

DRAFT

RCRA Facility Investigation-Remedial Investigation/  
Corrective Measures Study-Feasibility Study Report  
for the Rocky Flats Environmental Technology Site  
Appendix A – Comprehensive Risk Assessment

Volume 8 of 15  
Risk Assessment for the Lower Walnut Drainage  
Exposure Unit

This Draft was prepared by Kaiser-Hill Company, L.L.C.  
for the U.S. Department of Energy



ADMIN RECORD

October 2005

## TABLE OF CONTENTS

<b>ACRONYMS AND ABBREVIATIONS.....</b>	<b>vii</b>
<b>EXECUTIVE SUMMARY .....</b>	<b>ES-1</b>
<b>1.0 LOWER WALNUT DRAINAGE EXPOSURE UNIT.....</b>	<b>1</b>
1.1 Lower Walnut Drainage Exposure Unit Description.....	1
1.1.1 Exposure Unit Characteristics and Location.....	2
1.1.2 Topography and Surface Water Hydrology.....	2
1.1.3 Flora and Fauna.....	3
1.1.4 Preble's Meadow Jumping Mouse Habitat within Lower Walnut Exposure Unit .....	4
1.1.5 Data Description .....	5
1.2 Data Adequacy Assessment.....	8
1.3 Data Quality Assessment .....	8
<b>2.0 SELECTION OF HUMAN HEALTH CONTAMINANTS OF CONCERN..</b>	<b>8</b>
2.1 Contaminant of Concern Selection for Surface Soil/Surface Sediment .....	8
2.1.1 Surface Soil/Surface Sediment Cation/Anion and Essential Nutrient Screen .....	8
2.1.2 Surface Soil/Surface Sediment Preliminary Remediation Goals Screen.....	9
2.1.3 Surface Soil/Surface Sediment Detection Frequency Screen .....	9
2.1.4 Surface Soil/Surface Sediment Background Analysis.....	9
2.1.5 Surface Soil/Surface Sediment Professional Judgment Evaluation .....	10
2.2 Contaminant of Concern Selection for Subsurface Soil/Subsurface Sediment .....	10
2.2.1 Subsurface Soil/Subsurface Sediment Cation/Anion and Essential Nutrient Screen .....	10
2.2.2 Subsurface Soil/Subsurface Sediment Preliminary Remediation Goal Screen.....	10
2.2.3 Subsurface Soil/Subsurface Sediment Detection Frequency Screen .....	11
2.2.4 Subsurface Soil/Subsurface Sediment Background Analysis.....	11
2.2.5 Subsurface Soil/Subsurface Sediment Professional Judgment Evaluation .....	11
2.3 Contaminant of Concern Selection Summary.....	11
<b>3.0 HUMAN HEALTH EXPOSURE ASSESSMENT.....</b>	<b>11</b>
<b>4.0 HUMAN HEALTH TOXICITY ASSESSMENT .....</b>	<b>11</b>
<b>5.0 HUMAN HEALTH RISK CHARACTERIZATION.....</b>	<b>11</b>
<b>6.0 UNCERTAINTIES ASSOCIATED WITH THE HUMAN HEALTH RISK     ASSESSMENT .....</b>	<b>12</b>
6.1 Uncertainties Associated With the Data .....	12
6.2 Uncertainties Associated With Screening Values.....	12
6.2.1 Uncertainties Associated with Potential Contaminants of Concern without Preliminary Remediation Goals.....	13

6.3	Uncertainties Associated with Eliminating Potential Contaminants of Concern Based on Professional Judgment.....	13
6.4	Uncertainties Evaluation Summary .....	13
<b>7.0</b>	<b>IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN.....</b>	<b>13</b>
7.1	Data Used in the Ecological Risk Assessment .....	14
7.2	Identification of Surface Soil Ecological Contaminants of Potential Concern .....	15
7.2.1	Comparison with No Observed Adverse Effect Level (NOAEL) Ecological Screening Levels.....	15
7.2.2	Surface Soil Frequency of Detection Evaluation.....	15
7.2.3	Surface Soil Background Comparisons .....	15
7.2.4	Exposure Point Concentration Comparisons to Threshold ESLs (tESLs) .....	16
7.2.5	Surface Soil Professional Judgment Evaluation .....	17
7.2.6	Summary of Surface Soil Ecological Contaminants of Potential Concern .....	17
7.3	Identification of Subsurface Soil Ecological Contaminants of Potential Concern .....	18
7.3.1	Comparison to No Observed Adverse Effect Level (NOAEL) Ecological Screening Levels.....	18
7.3.2	Subsurface Soil Detection Frequency Evaluation.....	18
7.3.3	Subsurface Soil Background Comparison .....	18
7.3.4	Exposure Point Concentration Comparisons to Threshold ESLs ..	19
7.3.5	Subsurface Soil Professional Judgment .....	19
7.3.6	Summary of Subsurface Soil Ecological Contaminants of Potential Concern .....	19
7.4	Summary of Ecological Contaminants of Potential Concern .....	19
<b>8.0</b>	<b>ECOLOGICAL EXPOSURE ASSESSMENT.....</b>	<b>20</b>
8.1	Exposure Point Concentrations.....	20
8.2	Receptor-Specific Exposure Parameters .....	20
8.3	Bioaccumulation Factors .....	21
8.4	Intake and Exposure Estimates .....	21
<b>9.0</b>	<b>ECOLOGICAL TOXICITY ASSESSMENT .....</b>	<b>21</b>
<b>10.0</b>	<b>ECOLOGICAL RISK CHARACTERIZATION.....</b>	<b>22</b>
10.1	Chemical Risk Characterization .....	23
10.1.1	4,4-DDT .....	25
10.2	Ecosystem Characterization.....	26
10.3	General Uncertainty Analysis.....	28
10.3.1	Uncertainties Associated With Data Adequacy and Quality .....	29
10.3.2	Uncertainties Associated with the Lack of Toxicity Data for Ecological Contaminant of Interest Detected at the Lower Walnut Drainage Exposure Unit.....	29
10.3.3	Uncertainties Associated With Eliminating Ecological Contaminants of Interest Based on Professional Judgment.....	29
10.4	Summary of Significant Sources of Uncertainty .....	30

<b>11.0</b>	<b>SUMMARY AND CONCLUSIONS .....</b>	<b>30</b>
11.1	Human Health .....	30
11.2	Ecological Risk .....	30
<b>12.0</b>	<b>REFERENCES.....</b>	<b>31</b>

### LIST OF TABLES

Table 1.1	LWNEU IHSSs
Table 1.2	Number of Samples in Each Medium by Analyte Suite
Table 1.3	Summary of Detected Analytes in Surface Soil/Surface Sediment
Table 1.4	Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment
Table 1.5	Summary of Detected Analytes in Surface Soil
Table 1.6	Summary of Detected Analytes in Surface Soil (PMJM Habitat)
Table 1.7	Summary of Detected Analytes in Subsurface Soil
Table 2.1	Essential Nutrient Screen for Surface Soil/Surface Sediment
Table 2.2	PRG Screen for Surface Soil/Surface Sediment
Table 2.3	Statistical Distributions and Comparison to Background for LWNEU
Table 2.4	Essential Nutrient Screen for Subsurface Soil/Subsurface Sediment
Table 2.5	PRG Screen for Subsurface Soil/Subsurface Sediment
Table 2.6	Summary of the COC Selection Process
Table 6.1	Detected PCOCs without PRGs in each Medium by Analyte Suite
Table 7.1	Comparison of MDCs in Surface Soil to NOAEL ESLs for Terrestrial Plants, Invertebrates, and Vertebrates in the LWNEU
Table 7.2	Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the LWNEU
Table 7.3	Comparison of MDCs in Surface Soil with NOAEL ESLs for the PMJM in the LWNEU
Table 7.4	Statistical Distribution and Comparison to Background for Surface Soil (Non-PMJM) in LWNEU
Table 7.5	Statistical Distribution and Comparison to Background for Surface Soil in PMJM Habitat in the LWNEU

Table 7.6	Statistical Concentrations in Surface Soil (Non-PMJM) in the LWNEU
Table 7.7	Upper-Bound Exposure Point Concentration Comparison to Limiting tESLs in the LWNEU Surface Soil (Non-PMJM)
Table 7.8	Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Small Home Range Receptors in the LWNEU Surface Soil (Non-PMJM)
Table 7.9	Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Large Home Range Receptors in the LWNEU Surface Soil
Table 7.10	Summary of ECOPC Screening Steps for Surface Soil Non-PMJM Receptors in the LWNEU
Table 7.11	Summary of ECOPC Screening Steps for Surface Soil PMJM Receptors in the LWNEU
Table 7.12	Comparison of MDCs in Subsurface Soil to NOAEL ESLs for Burrowing Receptors in the LWNEU
Table 7.13	Statistical Distributions and Comparison to Background for Subsurface Soil in the LWNEU
Table 7.14	Statistical Concentrations in Subsurface Soil in the LWNEU
Table 7.15	Upper-Bound Exposure Point Concentration Comparison to tESLs in the LWNEU Surface Soil
Table 7.16	Summary of ECOPC Screening Steps for Subsurface Soil in the LWNEU
Table 8.1	Summary of ECOPC/Receptor Pairs
Table 8.2	Surface Soil Exposure Point Concentrations for Non-PMJM Receptors
Table 8.3	Surface Water Exposure Point Concentrations for Non-PMJM Receptors
Table 8.4	Receptor-Specific Exposure Parameters
Table 8.5	Receptor-Specific Intake Estimates
Table 9.1	TRVs for Terrestrial Vertebrate Receptors
Table 10.1	Hazard Quotient Summary for Non-PMJM Receptors
Table 10.2	Tier 2 Grid Cell Hazard Quotients for Surface Soil in LWNEU
Table 11.1	Summary of Risk Characterization Results for the LWNEU

## **LIST OF FIGURES**

- Figure 1.1 Rocky Flats Environmental Technology Site Exposure Units
- Figure 1.2 Topography and Historical IHSS Locations in the Lower Walnut Drainage Exposure Unit
- Figure 1.3 Aerial Photograph of Lower Walnut Drainage Exposure Unit, July 2005
- Figure 1.4 Vegetation in the Lower Walnut Drainage Exposure Unit
- Figure 1.5 Preble's Meadow Jumping Mouse Habitat and Surface Soil Sample Locations in the Lower Walnut Drainage Exposure Unit
- Figure 1.6 Lower Walnut Drainage Exposure Unit Surface Soil and Surface Sediment Sample Locations
- Figure 1.7 Lower Walnut Drainage Exposure Unit Subsurface Soil and Subsurface Sediment Sample Locations
- Figure 8.1 Tier 2 EPC 30-Acre Grids with Surface Soil Sample Locations
- Figure 10.1 Lower Walnut Drainage Exposure Unit Sample by Sample Comparison to the Limiting ESL – 4,4'-DDT

## **LIST OF ATTACHMENTS**

- Attachment 1 Detection Limit Screen
- Attachment 2 Data Quality Assessment
- Attachment 3 Statistical Analyses and Professional Judgment
- Attachment 4 Risk Assessment Calculations
- Attachment 5 Chemical-Specific Uncertainty Analysis
- Attachment 6 CRA Analytical Data Set

## ACRONYMS AND ABBREVIATIONS

µg/kg	microgram per kilogram
µg/L	microgram per liter
AEU	Aquatic Exposure Unit
AI	adequate intake
BAF	bioaccumulation factor
bgs	below ground surface
BZ	Buffer Zone
CAD/ROD	Corrective Action Decision/Record of Decision
CD	compact disc
CDH	Colorado Department of Health
CDPHE	Colorado Department of Public Health and Environment
cfs	cubic feet per second
CMS	Corrective Measures Study
CNHP	Colorado Natural Heritage Program
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
DRI	dietary reference intake
ECOI	ecological contaminant of interest
ECOPC	ecological contaminant of potential concern
EcoSSL	ecological soil screening level
EPA	U.S. Environmental Protection Agency

EPC	exposure point concentration
ERA	Ecological Risk Assessment
ESL	ecological screening level
EU	Exposure Unit
HHRA	Human Health Risk Assessment
HQ	hazard quotient
HRR	Historical Release Report
IA	Industrial Area
IAG	Interagency Agreement
IDEU	Inter-Drainage Exposure Unit
IHSS	Individual Hazardous Substance Site
kg	kilogram
LOAEL	lowest observed adverse effect level
LOEC	lowest effects concentration
LWNEU	Lower Walnut Drainage Exposure Unit
LWOEU	Lower Woman Drainage Exposure Unit
MDC	maximum detected concentration
mg	milligram
mg/day	milligram per day
mg/kg	milligram per kilogram
mg/kg/BW/day	milligram per kilogram receptor body weight per day
mg/l	milligram per liter
mL	milliliter
mL/day	milliliter per day
N/A	not applicable or not available

NFAA	No Further Accelerated Action
NNEU	No Name Gulch Drainage Exposure Unit
NOAEL	no observed adverse effect level
NOEC	No observed effect concentration
OU	Operable Unit
PAC	Potential Area of Concern
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
pCi	picocurie
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
QAPjP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RCEU	Rock Creek Drainage Exposure Unit
RCRA	Resource Conservation and Recovery Act
RDA	recommended daily allowance
RDI	recommended daily intake
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SCM	Site Conceptual Model

tESL	threshold ESL
TRV	toxicity reference value
UBC	Under Building Contamination
UCL	upper confidence limit
UL	upper limit daily intake
UT	uncertain toxicity
UTL	upper tolerance limit
UWNEU	Upper Walnut Drainage Exposure Unit
VOC	volatile organic compound
WBEU	Wind Blown Area Exposure Unit
WRV	wildlife refuge visitor
WRW	wildlife refuge worker

## EXECUTIVE SUMMARY

This report presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the 390-acre Lower Walnut Drainage Exposure Unit (EU) (LWNEU) at the Rocky Flats Environmental Technology Site (RFETS). The purpose of this report is to assess potential risks to human health and ecological receptors posed by exposure to contaminants of concern (COCs) and ecological contaminants of potential concern (ECOPCs) remaining at the LWNEU after completion of accelerated actions at RFETS.

Results of the COC selection process for the HHRA indicate that no COCs were selected and there are no significant human health risks from RFETS-related operations at the LWNEU. As a result, potential health risks for the wildlife refuge worker (WRW) and wildlife refuge visitor (WRV) are expected to be within the range of background risks. The estimated cancer risks for the WRW and WRV associated with potential exposure to background levels of naturally occurring metals in surface soil/surface sediment are both approximately  $2\text{E-}06$ . The estimated noncancer hazard indices associated with potential exposure to background levels of metals in surface soil/surface sediment are approximately 0.3 for the WRW and 0.1 for the WRV.

In the ERA, ECOPCs in surface soil were identified for non-Preble's meadow jumping mouse (PMJM) receptors only (4,4'-DDT). No ECOPCs in surface soil were identified for PMJM receptors, and no ECOPCs in subsurface soil were identified for burrowing receptors. The ECOPC/receptor pairs were evaluated in the risk characterization using a range of exposure point concentrations, exposure scenarios, and toxicity reference values to give a range of risk estimates. Overall, no significant risks to ecological receptors that may use the LWNEU are predicted.

In addition, the high species diversity and continued use of the site by numerous vertebrate species verify that habitat quality for these species remains acceptable and the ecosystem functions are being maintained. Data collected on wildlife abundance and diversity indicate that wildlife populations are stable and species richness remains high during remediation activities at RFETS, including wildlife using the LWNEU. Overall, no significant risk to survival, growth, and reproduction is predicted for the non-PMJM ecological receptors evaluated in the LWNEU.

## 1.0 LOWER WALNUT DRAINAGE EXPOSURE UNIT

This volume of the Comprehensive Risk Assessment (CRA) presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the Lower Walnut Drainage Exposure Unit (EU) (LWNEU) at Rocky Flats Environmental Technology Site (RFETS) (Figure 1.1).

The HHRA and ERA methods and selection of receptors are described in detail in the Final CRA Work Plan and Methodology (DOE 2005a), hereafter referred to as the CRA Methodology. A summary of the risk assessment methods, including updates made in consultation with the regulatory agencies, are summarized in Appendix A, Volume 2, Section 2.0 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report). The anticipated future land use of RFETS is a wildlife refuge. Consequently, two human receptors, a wildlife refuge worker (WRW) and a wildlife refuge visitor (WRV), are evaluated in this risk assessment consistent with this land use. A variety of representative terrestrial and aquatic receptors are evaluated in the ERA. The assessment of the LWNEU includes all terrestrial receptors named in the CRA Methodology, including the Preble's meadow jumping mouse (PMJM), a federally listed threatened species present at RFETS.

### 1.1 Lower Walnut Drainage Exposure Unit Description

This section provides a brief description of the LWNEU, including its location at RFETS, historical activities in the area, topography, surface water features, vegetation, and ecological resources. A more detailed description of these features and additional information regarding the geology, hydrology, and soil types at RFETS is included in Section 2.0, Physical Characteristics of the Study Area, of the RI/FS Report.

The Historical Release Report (HRR) and its annual updates provide descriptions of known or suspected releases of hazardous substances that occurred at RFETS. The original HRR (DOE 1992a) organized these known or suspected historical sources of contamination as Individual Hazardous Substance Sites (IHSSs), Potential Areas of Concern (PACs), or Under Building Contamination (UBC) sites (hereafter collectively referred to as historical IHSSs). Individual historical IHSSs and groups of historical IHSSs were also designated as Operable Units (OUs). Over the course of cleanup under the 1991 Interagency Agreement (IAG) and the 1996 Rocky Flats Cleanup Agreement (RFCA), the U.S. Department of Energy (DOE) has thoroughly investigated and characterized contamination associated with these historical IHSSs. Historical IHSSs have been dispositioned through appropriate remedial actions or by determining that No Further Accelerated Action (NFAA) is required, pursuant to the applicable IAG and RFCA requirements. Some OUs have also been dispositioned in accordance with an OU-specific Corrective Action Decision/Record of Decision (CAD/ROD).

A more detailed description of the regulatory agreements and the investigation and cleanup history under these agreements is contained in Section 1.0 of the RI/FS Report. Section 1.4.3 of the RI/FS Report describes the accelerated action process, while the disposition of all historic IHSSs at RFETS is summarized in Table 1.4 of the RI/FS Report. The 2005 Annual Update to the HRR (DOE 2005b) provides a description of the potential contaminant releases for each IHSS, and any interim response to the releases; identification of potential contaminants based on process knowledge and site data; data collection activities; accelerated action activities (if any); and the basis for recommending no further accelerated action.

The LWNEU is located within the Buffer Zone (BZ) OU, north-east of the Industrial Area (IA) that was used for RFETS operations (Figure 1.1). According to the 2005 Annual Update to the HRR (DOE 2005b), the LWNEU contains one IHSS (Table 1.1), the Flume Pond (NE-142.12), also referred to as Retention Pond A-5. The Flume Pond is located on Walnut Creek immediately west of and upstream from Indiana Street (Figure 1.2). The Flume Pond is proposed for NFAA and is included in the Draft Data Summary Report for IHSS Group NE-1.

#### **1.1.1 Exposure Unit Characteristics and Location**

The 390-acre LWNEU is located on the northeastern perimeter of RFETS (Figure 1.1) and has several distinguishing features:

- The LWNEU is located within the BZ OU and outside the Industrial Area (IA) that was used historically for manufacturing and processing operations at RFETS.
- Documented historical source areas are limited within the LWNEU boundaries. The EU contains one historical IHSS and is located topographically and hydraulically downgradient relative to the IA and the terminal ponds. Winds, although variable, are predominately from the northwest. Therefore, the LWNEU is not in a predominantly downwind direction.
- The LWNEU is immediately downstream of the confluence of North and South Walnut Creeks and No Name Gulch, which form Walnut Creek. Surface water releases from the A- and B-series ponds pass through Walnut Creek.
- The LWNEU is bound by the Inter-Drainage EU (IDEU), No Name Gulch Drainage EU (NNEU), and Upper Walnut Drainage EU (UWNEU) to the west, and the Wind Blown Area EU (WBEU) to the south (Figure 1.1). Land north and east of the LWNEU, outside of the RFETS boundary, is existing open space.

#### **1.1.2 Topography and Surface Water Hydrology**

The LWNEU is located within the easternmost portion of the Walnut Creek drainage basin at RFETS and includes portions of Dry Creek, Upper Church Ditch, McKay Ditch, and Walnut Creek (Figures 1.2 and 1.3).

Dry Creek, located in the northwestern part of the LWNEU, is usually dry, with flow only after sufficiently large precipitation events trigger runoff.

Upper Church Ditch runs along the northern boundary of the LWNEU and is owned and operated by the City of Broomfield. Upper Church Ditch is a seldom-used, though still-active water conveyance structure that diverts water from Coal Creek to Upper Church Lake and the Great Western Reservoir.

McKay Ditch, which is also owned and operated by the City of Broomfield, enters the LWNEU from the west and diverts water from the South Boulder Diversion Canal to the Great Western Reservoir for irrigation. McKay Ditch is generally dry, except in the spring. The ditch runs from west to east across the northern BZ, and is hydrologically isolated from the former IA. McKay Ditch was formerly a tributary to Walnut Creek within the LWNEU. However, in 1999, an underground pipeline was constructed in the northeast BZ to reroute McKay Ditch water and prevent it from co-mingling with water in Walnut Creek discharged from the RFETS retention ponds (see Figures 1.2 and 1.3). The pipeline daylights on the east side of Indiana Street. This configuration allows the City of Broomfield to divert water from either Coal Creek or the South Boulder Diversion Canal (both west of RFETS) directly into the Great Western Reservoir, where the water is stored by the City of Broomfield to be used for irrigation.

Downstream from Terminal Ponds A-4 and B-5, North and South Walnut Creeks merge to form Walnut Creek. All water flowing off site via Walnut Creek passes through the Flume Pond. When buildings and pavement existed in the IA, the mean annual discharge volume measured at gaging station GS03 (at Walnut Creek and Indiana Street) was approximately 479 acre-feet per year (based on flow records from October 1, 1996, to September 20, 2003). The peak flow rate measured during the same period was 56.5 cubic feet per second (cfs). Flow rates and volume in Walnut Creek following closure are expected to be substantially reduced compared to flows when the IA existed.

### 1.1.3 Flora and Fauna

Many of the plant communities found at RFETS are present within the LWNEU, as shown on a vegetation map for the LWNEU in Figure 1.4. Mesic-mixed grassland is the dominant vegetation community. Other plant communities comprise xeric tallgrass prairie and xeric needle and thread grasslands on the pediment; short upland shrubland and seep-fed wetlands on hillsides; and riparian woodlands and wetlands on the valley floor. Reclaimed grasslands are found where projects creating surface disturbances (such as the McKay Ditch underground pipeline) have been reseeded.

The mesic-mixed grassland is distinguished at RFETS by such plant species as western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), side-oats grama (*Bouteloua curtipendula*), prairie junegrass (*Koeleria pyramidata*), Canada bluegrass, Kentucky bluegrass, green needlegrass (*Stipa virigula*), and little bluestem (*Andropogon scoparius*). Land that is within the LWNEU was heavily grazed during past land use. However, since the purchase of land by DOE, grazing within the EU has not occurred in decades and plant communities have nearly returned to pre-grazed conditions. Mesic grasslands are important to wildlife, and grassland conditions are good on the eastern side of RFETS, including the LWNEU; however, weeds have degraded grasslands in some areas (PTI 1997).

The Colorado Natural Heritage Program (CNHP) considers the riparian woodlands found in LWNEU and throughout RFETS as rare and declining plant communities across the Great Plains. These plant communities provide habitat for a disproportionate number of species given their size. The presence of woody vegetation (i.e., trees and shrubs) in an arid environment provides vital habitat to songbirds, raptors, amphibians, and mammals as well as many invertebrate groups.

Numerous animal species have been observed at RFETS and most of these species are expected to be present in the LWNEU. Common large and medium-sized mammals likely to live or frequent the LWNEU include mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), and desert cottontail (*Sylvilagus audubonii*). The most common reptile observed at RFETS is the western prairie rattlesnake (*Crotalis viridis*) and the most common amphibian is the boreal chorus frog (*Pseudacris triseriatus*). Common birds include red-winged blackbird (*Agelaius phoeniceus*), song sparrow (*Melospiza melodia*), meadow lark (*Sturnella neglecta*), and vesper sparrow (*Pooecetes gramineus*). The most common small mammal species include deer mouse (*Peromyscus maniculatus*), prairie vole (*Microtus ochrogaster*), meadow vole (*Microtus pennsylvanicus*), and different species of harvest mice (*Reithrodontomys* sp.).

More information on the plant communities and animal species that exist within RFETS is provided in Section 2.0 of the RI/FS Report.

#### **1.1.4 Preble's Meadow Jumping Mouse Habitat within Lower Walnut Exposure Unit**

LWNEU supports habitat for the federally protected PMJM (*Zapus hudsonius preblei*), which have been captured within LWNEU for over a decade (DOE 1995d; K-H 1997a, 2000, 2002a and 2002b). Lower Walnut Creek supports approximately 13 ( $\pm 1$ ) individuals in the middle and lower portions of the EU (K-H 2000). The preferred habitat for the PMJM is the riparian corridors bordering RFETS' streams, ponds, and wetlands with an adjacent thin band of upland grasslands. Although habitat is found along streams throughout LWNEU, few PMJM have been found in the western portion of the EU approaching the terminal dams. PMJM observed in the EU do not travel upstream to UWNEU or NNEU, suggesting PMJM in the LWNEU are isolated from other subpopulations found on RFETS.

Sitewide PMJM habitat patches were developed in an effort to characterize habitat discontinuity and provide indications of varying habitat quality. The locations of the PMJM patches within the LWNEU are depicted in Figure 1.5. These patches aid in the evaluation of surface soil within PMJM habitat, giving a spatial understanding of areas that may be used by individual or subpopulations of PMJM. More detail on the methodology of creating sitewide PMJM habitat patches can be found in Appendix A, Volume 2, Section 3.2 of the RI/FS Report.

PMJM habitat within the LWNEU was divided into three habitat patches, each containing habitat capable of supporting at least several PMJM individuals. The patches vary in size

and shape dependent on their location within the Lower Walnut Creek drainage as well as the discontinuity or habitat quality of surrounding patches. The following is a brief discussion of the three patches within the LWNEU (Figure 1.5) and the reasons each is considered distinct:

- Patch #10 – This patch contains marginal habitat along McKay Ditch. Vegetation within the patch is comprised of riparian woodlands and wet meadows. Willow riparian shrubs, cattails, and reclaimed grasslands are also present. The boundaries for this patch correspond to habitat boundaries mapped earlier by the U.S. Fish and Wildlife Service (USFWS 2004). Although the proper vegetation characteristics are present, McKay Ditch rarely contains water and, therefore, habitat quality is low. No PMJM have been found in this patch. Patch #10 also includes a section of habitat that extends into the NNEU.
- Patch #13 – This patch is located at the confluence of North and South Walnut Creeks and contains habitat below the terminal ponds (Pond A-4 and B-5). The vegetation is dominated by short marsh and narrow creek channels that are often dry. A few trees are present, but willow shrubs are absent. The upstream boundary for this patch is where habitat ends (USFWS 2004) and the downstream margin is where contiguous riparian vegetation begins (K-H 1997b). Although all the habitat components are present, the narrow incised channels are of lower-quality habitat compared to areas downstream. No PMJM have been found in this patch. Patch #13 also includes a small section of habitat that extends into the UWNEU.
- Patch #14 – This patch contains higher-quality habitat compared to Patch #13 and supports PMJM. The upstream boundary of the patch is where contiguous riparian woodland vegetation begins, and the downstream periphery is marked by the RFETS boundary. Shrubby riparian vegetation with a thick understory of herbaceous growth is present in a contiguous section until the creek's confluence with the Flume Pond. Large expanses of snowberry shrubs are found between riparian vegetation and mesic grasslands. It has been estimated that this patch can support approximately 13 PMJM (K-H 2000).

### 1.1.5 Data Description

Data have been collected at RFETS under regulatory agency-approved Work Plans, Sampling and Analysis Plans (SAPs), and Quality Assurance Project Plans (QAPjPs) to meet data quality objectives (DQOs) and appropriate U.S. Environmental Protection Agency (EPA) and Colorado Department of Public Health and Environment (CDPHE) guidance. Surface soil, subsurface soil, surface sediment, subsurface sediment, and groundwater samples were collected from the LWNEU. Surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil are the media evaluated in the HHRA and ERA (Table 1.2). The sampling locations for these media are shown on Figures 1.6 and 1.7, and data summaries for detected analytes in each medium are provided in Tables 1.3 through 1.7. Potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) that were analyzed for but not detected, or were detected in less than 5 percent of the samples are presented in Attachment 1.

Detection limits are compared to preliminary remediation goals (PRGs) and ecological screening levels (ESLs) and discussed in Attachment 1 (Tables A1.1 through A1.4). Only data from June 1991 to the present are used in the CRA because these data meet the approved analytical Quality Assurance/Quality Control (QA/QC) requirements.

In accordance with the CRA Methodology, only data collected on or after June 28, 1991, and data for subsurface soil and subsurface sediment samples with a start depth less than or equal to 8 feet below ground surface (bgs) are used in the CRA. Subsurface soil and subsurface sediment data are limited to this depth because it is not anticipated that the WRW or burrowing animals will dig to deeper depths. A detailed description of data storage and processing methods is provided in Appendix A, Volume 2 of the RI/FS Report. The CRA analytical data set for the LWNEU is provided on a compact disc (CD) presented in Attachment 6. The CD in Attachment 6 includes the data used in the CRA as well as data not considered useable based on criteria presented in Appendix A, Volume 2 of the RI/FS Report.

The sampling data used for the LWNEU HHRA and ERA are as follows:

- Combined surface soil/surface sediment data (HHRA);
- Combined subsurface soil/subsurface sediment data (HHRA);
- Surface soil data (ERA); and,
- Subsurface soil data (ERA).

The data for these media are briefly described below.

Surface water and sediment are assessed for ecological receptors on an Aquatic Exposure Unit (AEU) basis in Appendix A, Volume 15 of the RI/FS Report. An assessment of the surface water, groundwater-to-surface water, and volatilization pathways for human health are presented in Appendix A, Volume 2 of the RI/FS Report.

#### ***Surface Soil/Surface Sediment***

The combined surface soil/surface sediment data set for the LWNEU consists of up to 81 samples that were analyzed for inorganics (29 samples), organics (15 samples), and radionuclides (81 samples) (Table 1.2). The data include sediment samples collected to depths down to 0.5 feet below ground surface (bgs). The surface soil sampling density is highest at and near the Flume Pond but the entire site was covered during the 30-acre sampling. For the grid sampling, five individual samples were collected and composited from each 30-acre cell, one from each quadrant and one in the center, as described in the CRA SAP Addendum 04-01 (DOE 2004). Sampling locations on Figure 1.6 denoted with D or E, followed by a second letter (such as P or V, for example), identify 30-acre grid samples. The sampling locations for surface soil and surface sediment are shown on Figure 1.6. Twenty-one surface sediment samples were collected from the LWNEU, two from McKay Ditch and the remainder from Walnut Creek.

The data summary for detected analytes in surface soil/surface sediment for the LWNEU is presented in Table 1.3. Detected analytes included representatives from the inorganics, organics, and radionuclides analyte groups.

#### ***Subsurface Soil/Subsurface Sediment***

The combined subsurface soil/subsurface sediment data set for the LWNEU consists of up to 20 samples analyzed for inorganics, 21 for organics, and 17 for radionuclides (Table 1.2). The data include subsurface sediment samples with a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet. The sampling locations for subsurface soil and subsurface sediment are shown on Figure 1.7.

The data summary for subsurface soil/subsurface sediment in the LWNEU is presented in Table 1.4. Detected analytes included representatives from the inorganics, organics, and radionuclides analyte groups.

#### ***Surface Soil***

Data meeting the CRA requirements are available for up to 57 surface soil samples collected in the LWNEU that were analyzed for inorganics (23 samples), organics (12 samples), and radionuclides (57 samples) (Table 1.2). The surface soil sampling locations for the LWNEU are shown on Figure 1.6. The surface soil sampling density is highest at and near the Flume Pond but the entire site was covered during the 30-acre sampling. For the grid sampling, five individual samples were collected and composited from each 30-acre cell, one from each quadrant and one in the center, as described in the CRA SAP Addendum 04-01 (DOE 2004). Sampling locations on Figure 1.6 denoted with D or E, followed by a second letter (such as P or V, for example), identify 30-acre grid samples.

The data summary for detected analytes in LWNEU surface soil is presented in Table 1.5. The data summary for the detected analytes for those samples within designated PMJM habitat is presented in Table 1.6. Radionuclides, organics, and inorganics were detected in LWNEU surface soil samples. A summary of analytes that were either not detected, or detected in less than 5 percent of samples in surface soil in the LWNEU is presented and discussed in Attachment 1.

#### ***Subsurface Soil***

The subsurface soil data set for the LWNEU consists of up to 16 samples. All 16 samples were analyzed for organics, 14 for inorganics, and 11 for radionuclides (Table 1.2). Subsurface soil sampling locations are shown on Figure 1.7. Almost all subsurface soil sampling locations are at or near IHSS 142.12. Subsurface soil samples used in the CRA are defined in the CRA Methodology as soil samples with a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet.

The data summary for detected analytes in subsurface soil for the LWNEU is presented in Table 1.7. Subsurface soil samples were analyzed for inorganics, organics, and radionuclides, and representatives from all three analyte groups were detected.

## **1.2 Data Adequacy Assessment**

A data adequacy assessment was performed to determine whether the available data set discussed in the previous section is adequate for risk assessment purposes. The data adequacy assessment rules are presented in the CRA Methodology, and a detailed data adequacy assessment for the data used in the CRA is presented in Appendix A, Volume 2 of the RI/FS Report. The adequacy of the data was assessed by examining the number of available samples for each analyte group in each medium for use in the CRA, the spatial and temporal representativeness of the data, as well as information on potential historical sources of contamination, migration pathways, and the concentration levels in the media. The assessment concludes that the data are adequate for the purposes of the CRA.

## **1.3 Data Quality Assessment**

A Data Quality Assessment (DQA) of the LWNEU data was conducted to determine whether the data were of sufficient quality for risk assessment use. The DQA is presented in Attachment 2, and an evaluation of the entire RFETS data set is presented in Appendix A, Volume 2 of the RI/FS Report. The quality of the laboratory results were evaluated for compliance with the CRA Methodology data quality objectives (DQOs) through an overall review of precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. This review concluded that the data are of sufficient quality for use in the CRA, and the CRA DQOs have been met.

## **2.0 SELECTION OF HUMAN HEALTH CONTAMINANTS OF CONCERN**

The human health contaminant of concern (COC) screening process is described in Section 4.4 of the CRA Methodology and summarized in Appendix A, Volume 2 of the RI/FS Report (Section 2.2).

The human health COC selection process was conducted for surface soil/surface sediment and subsurface soil/subsurface sediment in the LWNEU. Results of the COC selection process are summarized below.

### **2.1 Contaminant of Concern Selection for Surface Soil/Surface Sediment**

Detected PCOCs in surface soil/surface sediment samples (Table 1.3) are screened in accordance with the CRA Methodology to identify the COCs.

#### **2.1.1 Surface Soil/Surface Sediment Cation/Anion and Essential Nutrient Screen**

The major cations and anions that do not have toxicity criteria are eliminated from assessments in surface soil/surface sediment in accordance with the CRA Methodology.

The essential nutrient screen for analytes detected in surface soil/surface sediment is presented in Table 2.1. The screen includes PCOCs that are essential for human health

and do not have toxicity criteria available. Table 2.1 shows the maximum detected concentrations (MDCs) for essential nutrients, daily intake estimates based on the MDCs, and dietary reference intakes (DRIs). The DRIs are identified in the table as recommended daily allowances (RDAs), recommended daily intakes (RDIs), adequate intakes (AI), and upper limit daily intakes (ULs). The estimated daily maximum intakes based on the nutrients' MDCs and a surface soil/surface sediment ingestion rate of 100 milligrams per day (mg/day) are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for surface soil/surface sediment.

### **2.1.2 Surface Soil/Surface Sediment Preliminary Remediation Goals Screen**

Table 2.2 compares the MDCs and upper confidence limits (UCLs) to the WRW PRGs for each PCOC. If the MDC and the UCL are greater than the PRG, the PCOC is retained for further screening; otherwise, it is not further evaluated. Arsenic, cesium-134, and cesium-137, in surface soil/surface sediment had MDCs and UCLs that exceeded the PRGs and were retained as PCOCs. The MDC for radium-228 exceeded the PRG and was retained as a PCOC. The UCL for radium-228 in surface soil/surface sediment was not calculated based on the number of samples available.

PRGs were not available for several PCOCs in surface soil/surface sediment. Analytes without PRGs are listed on Table 2.2 and their effect on the conclusions of the risk assessment results is discussed in the uncertainty section (Section 6.0).

### **2.1.3 Surface Soil/Surface Sediment Detection Frequency Screen**

Arsenic was detected in more than 5 percent of surface soil/surface sediment samples and, therefore, was retained for further evaluation in the COC screen (Table 1.3). A detection frequency screen was not performed for cesium-134, cesium-137, and radium-228 in surface soil/surface sediment because all reported values for radionuclides are considered detects.

### **2.1.4 Surface Soil/Surface Sediment Background Analysis**

Results of the background statistical comparison for arsenic is presented in Table 2.3 and discussed in Attachment 3. Box plots for arsenic (both the LWNEU and background data sets) are provided in Attachment 3. Arsenic is the only PCOC that was statistically greater than background at the 0.1 significance level, and it is evaluated further in the professional judgment section. A background comparison could not be conducted for radium-228, because only one analysis was available for surface soil/surface sediment in the LWNEU. Radium-228 was also retained for professional judgment.

The results of the statistical comparisons indicate that site concentrations of cesium-134 and cesium-137 are not greater than those for background. Therefore, these analytes were not further evaluated as PCOCs in surface soil/surface sediment in the LWNEU.

### **2.1.5 Surface Soil/Surface Sediment Professional Judgment Evaluation**

Based on the weight of available evidence evaluated by professional judgment, PCOCs will either be included for further evaluation as COCs or excluded as COCs. The professional judgment evaluation takes into account process knowledge, spatial trends, pattern recognition, comparisons to RFETs background and other background data sets, and risk potential for human health and ecological receptors. As discussed in Section 1.2 and Attachment 2, the sample results are adequate for use in the professional judgment because they are of sufficient quality for use in the CRA.

Based on the weight of evidence described in Attachment 3, arsenic and radium-228 in surface soil/surface sediment in the LWNEU are not considered COCs because the weight of evidence supports the conclusion that arsenic and radium-228 concentrations in surface soil/surface sediment in the LWNEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations.

## **2.2 Contaminant of Concern Selection for Subsurface Soil/Subsurface Sediment**

Detected PCOCs in subsurface soil/subsurface sediment samples (Table 1.4) are screened in accordance with the CRA Methodology to identify the COCs.

### **2.2.1 Subsurface Soil/Subsurface Sediment Cation/Anion and Essential Nutrient Screen**

The major cations and anions that do not have toxicity criteria were eliminated from assessments in subsurface soil/subsurface sediment in accordance with the CRA Methodology.

Essential nutrients without toxicity criteria that were detected in subsurface soil/subsurface sediment in the LWNEU are compared to DRIs in Table 2.4. The estimated daily maximum intakes for these PCOCs, based on the nutrients' MDCs and a subsurface soil/subsurface sediment ingestion rate of 100 mg/day, are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for subsurface soil/subsurface sediment.

### **2.2.2 Subsurface Soil/Subsurface Sediment Preliminary Remediation Goal Screen**

The PRG screen for detected analytes in subsurface soil/subsurface sediment is presented in Table 2.5. The MDC and UCL for radium-228 were greater than the PRG. Radium-228 in subsurface soil/subsurface sediment in the LWNEU was retained for further evaluation in the COC selection process.

PRGs were not available for several PCOCs in subsurface soil/subsurface sediment. Analytes without PRGs are listed on Table 2.5 and their effect on the conclusions of the risk assessment results is discussed in the uncertainty section (Section 6.0).

### **2.2.3 Subsurface Soil/Subsurface Sediment Detection Frequency Screen**

A detection frequency screen was not performed for radium-228 in subsurface soil/subsurface sediment because all reported values for radionuclides are considered detects.

### **2.2.4 Subsurface Soil/Subsurface Sediment Background Analysis**

Results of the background statistical comparison for radium-228 is presented in Table 2.3 and discussed in Attachment 3. Box plots for radium-228 (both LWNEU and background) are provided in Attachment 3. Radium-228 was not statistically greater than background at the 0.1 significance level, and is therefore not further evaluated.

### **2.2.5 Subsurface Soil/Subsurface Sediment Professional Judgment Evaluation**

The professional judgment step was not performed for subsurface soil/subsurface sediment because there were no PCOCs retained after the background comparison.

## **2.3 Contaminant of Concern Selection Summary**

A summary of the results of the COC screening process is presented in Table 2.6. No COCs were selected for any of the media at the LWNEU.

## **3.0 HUMAN HEALTH EXPOSURE ASSESSMENT**

The Site Conceptual Model (SCM), presented in Figure 2.1 of the CRA Methodology and discussed in Appendix A, Volume 2 of the RI/FS Report, provides an overview of potential human exposures at RFETS for reasonably anticipated land use. However, all PCOCs were eliminated from further consideration as human health COCs for the LWNEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). A quantitative risk characterization is not necessary for the LWNEU and, therefore, an exposure assessment was not conducted.

## **4.0 HUMAN HEALTH TOXICITY ASSESSMENT**

Procedures and assumptions for the toxicity assessment are presented in the CRA Methodology. All PCOCs were eliminated from further consideration as human health COCs for the LWNEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). A quantitative risk characterization is not necessary for the LWNEU and therefore, a toxicity assessment was not conducted.

## **5.0 HUMAN HEALTH RISK CHARACTERIZATION**

Information from the exposure assessment and the toxicity criteria sections is integrated in this section to characterize risk to the WRW and WRV receptors. However, all PCOCs

were eliminated from further consideration as human health COCs based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). Therefore, a quantitative risk characterization was not performed for the LWNEU.

## **6.0 UNCERTAINTIES ASSOCIATED WITH THE HUMAN HEALTH RISK ASSESSMENT**

There are various types of uncertainties associated with steps of an HHRA. General uncertainties common to the EUs are discussed in Volume 2, Appendix A of the RI/FS Report. Uncertainties specific to the EU are described below.

### **6.1 Uncertainties Associated With the Data**

Data adequacy for this CRA is evaluated and discussed in Appendix A, Volume 2 of the RI/FS Report. Although there are some uncertainties associated with the sampling and analyses conducted for surface soil/surface sediment and subsurface soil/subsurface sediment at the LWNEU, data are considered adequate for the characterization of risk at the EU. The environmental samples for the LWNEU were collected from 1991 through 2005. The CRA sampling and analysis requirements for the BZ (DOE 2004, 2005a) specify that the minimum sampling density requirement for surface soil/surface sediment is one five-sample composite for every 30-acre grid cell. In surface soil/surface sediment, there are up to 81 samples in the LWNEU.

Another source of uncertainty in the data is the relationship of detection limits to the PRGs for analytes eliminated as COCs because they were not detected or had a low detection frequency (i.e., less than 5 percent). The detection limits were appropriate for the analytical methods used, and this is examined in greater detail in Attachment 1.

### **6.2 Uncertainties Associated With Screening Values**

The COC screening analyses utilized RFETS-specific PRGs based on a WRW scenario. The assumptions used in the development of these values were conservative. For example, it is assumed that a future WRW will consume 100 mg of surface soil/surface sediment for 230 days per year for a period of 18.7 years. In addition, a WRW is assumed to be dermally exposed to and inhale surface soil and surface sediment particles in the air. These assumptions are likely to overestimate actual exposures to surface soil for WRWs in the LWNEU because a WRW will not spend 100 percent of his or her time in this area. Exposure to subsurface soil and subsurface sediment is assumed to occur 20 days per year. The WRW PRGs for subsurface soil/subsurface sediment are also expected to conservatively estimate potential exposures because it is unlikely a WRW will excavate extensively in the LWNEU.

### **6.2.1 Uncertainties Associated with Potential Contaminants of Concern without Preliminary Remediation Goals**

PCOCs for the LWNEU for which PRGs are not available are listed in Table 6.1.

Uncertainties associated with the lack of PRGs for analytes listed in Table 6.1 are considered small. The listed inorganics are not usually included in HHRAs because they are not expected to result in significant human health impacts. Radionuclide PRGs are available for all detected individual radionuclides. Therefore, the lack of PRGs for the gross alpha and gross beta activities is not expected to affect the results of the HHRA.

### **6.3 Uncertainties Associated with Eliminating Potential Contaminants of Concern Based on Professional Judgment**

Arsenic and radium-228 in surface soil/surface sediment were eliminated as COCs based on professional judgment. There is no identified source or pattern of release for arsenic in the LWNEU and the slightly elevated median value of arsenic in the LWNEU is most likely due to natural variation. The slightly elevated concentrations of radium-228 compared to the PRG in the one surface soil/surface sediment sample analyzed for radium-228 in the LWNEU is also expected to be due to natural variations. The weight of evidence presented in Attachment 3, Section 4.0 supports the conclusion that the concentrations of arsenic and radium-228 are naturally occurring and not due to site activities. Uncertainty associated with the elimination of these chemicals as COCs is low.

No PCOCs were eliminated in subsurface soil/subsurface sediment based on professional judgment in the LWNEU.

### **6.4 Uncertainties Evaluation Summary**

Evaluation of the uncertainties associated with the data and the COC screening processes indicates there is reasonable confidence in the conclusions of the LWNEU risk characterization.

## **7.0 IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN**

The ecological contaminant of potential concern (ECOPC) identification process streamlines the ecological risk characterization for each EU by focusing the assessment on ecological contaminants of interest (ECOIs) that are present in the LWNEU. ECOIs are defined as any chemical detected in the LWNEU and are assessed for surface soils and subsurface soils. ECOIs for sediments and surface water are assessed in Appendix A, Volume 15 of the RI/FS Report. The ECOPC process is described in the CRA Methodology and additional details are provided in Appendix A, Volume 2 of the RI/FS Report. A detailed discussion of the SCM, including the receptors of concern, exposure pathways, and endpoints used in the ERA for the LWNEU, are also provided in

Appendix A, Volume 2 of the RI/FS Report. The ECOPC process is described in the CRA Methodology and additional details are provided in Appendix A, Volume 2 of the RI/FS Report.

The process is based on the SCM presented in the CRA Methodology and described in detail in Appendix A, Volume 2 of the RI/FS Report. The SCM presents the pathways of potential exposure from documented historical source areas (IHSSs and PACs) to the receptors of concern. Generally, the most significant exposure pathways for wildlife at the LWNEU are the ingestion of plant, invertebrate, or animal tissue that could have accumulated ECOIs from the source areas through direct uptake or dietary routes, as well as the direct ingestion of potentially contaminated media. For terrestrial plants and invertebrates, the most significant exposure pathway is direct contact with potentially contaminated soils.

The receptors of concern that were selected for assessment are listed in Table 7.1, and discussed in detail in Appendix A, Volume 2 of the RI/FS Report, and include representative birds and mammals in addition to the general plant and terrestrial invertebrate communities. The receptors were selected based on several criteria, including their potential to be found in the various habitats present within RFETS, their potential to come into contact with ECOIs, and the amount of life history and behavioral information available.

The ECOPC process consists of two separate evaluations, one for the PMJM receptor and one for non-PMJM receptors. The ECOPC identification process for the PMJM is conducted separately from non-PMJM receptors because the PMJM is a federally listed threatened species under the Endangered Species Act (63 FR 26517).

## 7.1 Data Used in the Ecological Risk Assessment

The following LWNEU data are used in the CRA:

- Fifty-seven surface soil samples were collected in the LWNEU and analyzed for inorganics (23 samples), organics (12 samples), and radionuclides (57 samples) (Table 1.2).
- Sixteen subsurface soil samples were analyzed for inorganics (14 samples), organics (16 samples), and radionuclides (11 samples) (Table 1.2).

A data summary is provided in Table 1.5 for surface soil, Table 1.6 for surface soils in PMJM habitat, and Table 1.7 for subsurface soil.

Sediment and surface water data for the LWNEU were also collected (Section 1.1.5) and are evaluated for the ERA in Appendix A, Volume 15 of the RI/FS Report.

The LWNEU has 18 sample locations occurring in PMJM habitat, which is described in greater detail in Section 1.1.4. Sampling locations and PMJM habitat patches within the LWNEU are shown in Figure 1.5.

## 7.2 Identification of Surface Soil Ecological Contaminants of Potential Concern

ECOPCs for surface soil were identified for non-PMJM and PMJM receptors in accordance with the sequence presented in the CRA Methodology.

### 7.2.1 Comparison with No Observed Adverse Effect Level (NOAEL) Ecological Screening Levels

In the first step of the ECOPC identification process, the MDCs of ECOIs in surface soil were compared to receptor-specific NOAEL ESLs. NOAEL ESLs for surface soil were developed in the CRA Methodology for three receptor groups: terrestrial vertebrates, terrestrial invertebrates, and terrestrial plants.

#### *Non-PMJM Receptors*

The NOAEL ESLs for non-PMJM receptors are compared to MDCs in surface soil in Table 7.1. The results of the NOAEL ESL screening analyses for all receptor types are summarized in Table 7.2. Analytes with a "Yes" in any of the "Exceedance" columns in Table 7.2 are evaluated further.

NOAEL ESLs were not available for several ECOI/receptor pairs (Tables 7.1 and 7.2). These ECOI/receptor pairs are discussed as ECOIs with uncertain toxicity in Section 10, along with the potential impacts to the risk assessment.

#### *PMJM Receptors*

The NOAEL ESLs for PMJM receptors were compared to the MDCs of ECOIs in surface soil collected from PMJM habitat (Table 7.3). The MDCs in surface soil that exceed the NOAEL ESLs are identified in Table 7.3 with a "Yes" in the column heading "Retained for Further Analysis?"

Analytes for which a PMJM NOAEL ESL is not available are identified with a "UT" in Table 7.3 under the column heading "Retained for Further Analysis?." These analytes are discussed in the uncertainty section (Section 10) as ECOIs with uncertain toxicity.

### 7.2.2 Surface Soil Frequency of Detection Evaluation

The ECOPC identification process for non-PMJM receptors involves an evaluation of detection frequency for each ECOI retained after the NOAEL screening step. If the detection frequency is less than 5 percent, then population-level risks are considered highly unlikely and the ECOI is not further evaluated. None of the chemicals detected in surface soil at the LWNEU that were retained after the NOAEL ESL screening step had a detection frequency less than 5 percent (Table 1.5). Therefore, no ECOIs were excluded based on the detection frequency evaluation for surface soil in the LWNEU.

### 7.2.3 Surface Soil Background Comparisons

The ECOIs retained after the NOAEL ESL screening and the detection frequency evaluation were then compared to site-specific background concentrations where

available. The background comparison is discussed in Attachment 3. The statistical methods used for the background comparison are summarized in Appendix A, Volume 2 of the RI/FS Report.

### ***Non-PMJM Receptors***

The results of the background comparisons for the non-PMJM receptors are presented in Table 7.4. The analytes listed as being retained as ECOIs in Table 7.4 are evaluated further using upper-bound EPCs in the following section.

### ***PMJM Receptors***

The background comparisons for PMJM receptors are conducted differently than for non-PMJM receptors because of their protected status. The results of this comparison are based on their location within PMJM habitat and are presented in Table 7.5. The analytes listed as "Yes" on Table 7.5 are further evaluated in the following sections.

## **7.2.4 Exposure Point Concentration Comparisons to Threshold ESLs (tESLs)**

The ECOIs retained after completion of all previous evaluations for non-PMJM receptors are then compared to tESLs using EPCs specific to small and large home-range receptors. The calculation of EPCs is described in Appendix A, Volume 2 of the RI/FS Report.

Statistical concentrations for each ECOI retained for the tESL screen are presented in Table 7.6. The EPC for small home-range receptors is the 95 percent UCL of the 90th percentile (upper tolerance limit [UTL]), or the MDC in the event that the UTL is greater than the MDC. The EPC for large home-range receptors is the UCL, or the MDC in the event that the UCL is greater than the MDC.

Small home-range receptors include terrestrial plants, terrestrial invertebrates, mourning dove, American kestrel, deer mouse, and black-tailed prairie dog. These receptors are evaluated by comparing the small home-range EPC (UTL) for each ECOI to the limiting (or lowest) small home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

Large home-range receptors, such as coyote and mule deer, are evaluated by comparing the large home-range EPC (UCL) for each ECOI to the limiting large home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

The EPC comparison to limiting tESLs for small and large home-range receptors is presented in Table 7.7. Analytes that exceed the limiting tESLs are further evaluated by comparing them to the receptor-specific tESLs (if available) to identify receptors of potential concern. Analytes exceeding the limiting tESLs for small home-range receptors are compared to receptor-specific tESLs in Table 7.8, and analytes exceeding limiting tESLs for large home-range receptors are compared to receptor-specific tESLs in Table 7.9.

Chemicals that exceed any tESLs (if available) are assessed in the professional judgment evaluation. Any analyte/receptor pairs that are retained through professional judgment are identified as ECOPCs and are carried forward in the risk characterization.

### **7.2.5 Surface Soil Professional Judgment Evaluation**

#### ***Non-PMJM Receptors***

Based on the weight-of-evidence, professional judgment described in Attachment 3, aluminum, antimony, boron, chromium, lithium, molybdenum, nickel, selenium, tin, vanadium, and zinc in surface soil at the LWNEU were not considered ECOPCs for non-PMJM receptors and are not further evaluated quantitatively.

4,4'-DDT was identified as an ECOPC and retained for further evaluation in the risk characterization.

#### ***PMJM Receptors***

Based on the weight-of-evidence, professional judgment described in Attachment 3, chromium and manganese in surface soil were not considered ECOPCs for PMJM receptors and are not further evaluated quantitatively.

### **7.2.6 Summary of Surface Soil Ecological Contaminants of Potential Concern**

The ECOPC screening process for surface soil is summarized below for non-PMJM receptors and PMJM receptors.

#### ***Non-PMJM Receptors***

Inorganic, organic, and radionuclide surface soil ECOIs for non-PMJM receptors in the LWNEU were eliminated from further consideration as ECOPCs based on one of the following: 1) the MDC of the ECOI was less than the lowest ESL; 2) no ESLs were available (these ECOIs are discussed in Section 10); 3) the concentration of the ECOI in LWNEU surface soils was not statistically greater than background surface soils; 4) the upper-bound EPC did not exceed the limiting tESL; or 5) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related ECOPC. Chemicals that were retained are identified as ECOPCs.

A summary of the ECOPC screening process for non-PMJM receptors is presented in Table 7.10. Receptors of potential concern for each ECOPC are also presented. The ECOPC/receptor pairs are evaluated further in Section 8.0 (Ecological Exposure Assessment), Section 9.0 (Ecological Toxicity Assessment), and Section 10.0 (Ecological Risk Characterization).

#### ***PMJM Receptors***

ECOIs in surface soil in PMJM habitat located within the LWNEU were evaluated in the ECOPC identification process. ECOIs were removed from further evaluation in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI was less than the NOAEL ESL for PMJM; 2) no NOAEL ESLs were available (these ECOIs are discussed in Section 10); 3) the ECOI concentrations within the PMJM habitat

in LWNEU were not statistically greater than those from background surface soils; or 4) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related ECOPC. The results of the ECOPC identification process for the PMJM are summarized in Table 7.11.

### **7.3 Identification of Subsurface Soil Ecological Contaminants of Potential Concern**

Subsurface soil sample locations for soil collected at a starting depth of 0.5 to 8 feet bgs in the LWNEU are identified on Figure 1.7. A data summary for subsurface soil less than 8 feet deep is presented in Table 1.6.

#### **7.3.1 Comparison to No Observed Adverse Effect Level (NOAEL) Ecological Screening Levels**

The CRA Methodology indicates subsurface soil is evaluated for those ECOIs that have greater concentrations in subsurface soil than in surface soil. As a conservative screening step, subsurface soil is evaluated for all EUs regardless of the presence/absence of a change in concentrations from surface soil and subsurface soil. The MDCs of ECOIs in subsurface soil were compared to NOAEL ESLs for burrowing receptors (Table 7.12). ECOIs with MDCs greater than the NOAEL ESL for the prairie dog are further evaluated in the ECOPC identification process.

NOAEL ESLs are not available for some analytes, and these are identified as "N/A" in Table 7.12. These constituents are considered ECOIs with uncertain toxicity (UT) and are discussed in the uncertainty analysis (Section 10).

#### **7.3.2 Subsurface Soil Detection Frequency Evaluation**

The ECOPC identification process for burrowing receptors involves an evaluation of detection frequency for each ECOI retained after the NOAEL ESL screening step. If the detection frequency is less than 5 percent, population-level risks are considered highly unlikely and the ECOI is not further evaluated. The detection frequencies for chemicals in subsurface soil are presented in Table 1.7. None of the chemicals in subsurface soil at the LWNEU that were retained after the NOAEL ESL screening step had a detection frequency of less than 5 percent. Therefore, no ECOIs were eliminated from further evaluation based on low detection frequencies for subsurface soil in the LWNEU.

#### **7.3.3 Subsurface Soil Background Comparison**

The ECOIs retained after the ESL screening and detection frequency evaluation were compared to site-specific background concentrations where available. The background comparison was conducted in the same manner as that for surface soil non-PMJM receptors using statistical comparisons.

Analyses were conducted to assess whether arsenic in LWNEU subsurface soil is statistically greater than that in sitewide background surface soil at the 0.1 level of significance.

The results of the statistical comparisons of the LWNEU data to background data indicate that site concentrations of arsenic in LWNEU subsurface soil are statistically greater than background concentrations. The results are summarized in Table 7.13.

#### **7.3.4 Exposure Point Concentration Comparisons to Threshold ESLs**

ECOs retained after all previous evaluations for burrowing receptors are compared to tESLs using EPCs specific to small home-range receptors. The calculation of EPCs is described in Appendix A, Volume 2 of the RI/FS Report.

Because only arsenic was retained following the background analysis step, statistical concentrations for arsenic are presented in Table 7.14. The EPC comparison to tESLs for burrowing receptors is presented in Table 7.15. The subsurface soil UTL for arsenic is lower than the tESL for the prairie dog receptor; therefore, it was not evaluated further.

#### **7.3.5 Subsurface Soil Professional Judgment**

ECOs with subsurface soil concentrations that exceed NOAEL ESLs, which have been detected in more than 5 percent of samples, that have slightly elevated concentrations compared to the background data, and which exceed tESLs are subject to a professional judgment evaluation. However, no ECOs had subsurface soil concentrations that exceeded tESLs; therefore, no weight-of-evidence, professional judgment evaluation was needed for subsurface soil in the LWNEU.

#### **7.3.6 Summary of Subsurface Soil Ecological Contaminants of Potential Concern**

All subsurface soil ECOs for burrowing receptors in the LWNEU were eliminated from further consideration as ECOPCs based on one of the following: 1) the MDC of the ECOI was less than NOAEL ESL for the burrowing receptor; 2) no ESLs were available (these ECOs are discussed in Section 10); 3) the concentration of the ECOI in LWNEU subsurface soils was not statistically greater than background subsurface soils; or 4) the upper-bound EPC was less than the tESL. The results of the subsurface soil ECOPC identification process for burrowing receptors are summarized in Table 7.16.

### **7.4 Summary of Ecological Contaminants of Potential Concern**

ECOs in surface and subsurface soil in the LWNEU were evaluated in the ECOPC identification process for non-PMJM receptors, PMJM receptors, and burrowing receptors. 4,4'-DDT was identified as an ECOPC for selected non-PMJM receptors (Table 7.10). No chemicals were identified as ECOPCs for the PMJM (Table 7.11). No chemicals were identified as ECOPCs for burrowing receptors (Table 7.16). No other ECOs were retained past the professional judgment step of the ECOPC identification

process for any other receptor group (non-PMJM receptors, PMJM receptors, or burrowing receptors).

## **8.0 ECOLOGICAL EXPOSURE ASSESSMENT**

The ECOPC identification process defined the steps necessary to identify those chemicals that could not reliably be removed from further consideration in the ERA process. The list of ECOPC/receptor pairs of potential concern (Table 8.1) represents those media, chemicals, and receptors in the LWNEU that require further assessment. The characterization of risk defines a range of potential exposures to site receptors from the ECOPCs and a parallel evaluation of the potential toxicity of each of the ECOPCs as well as the uncertainties associated with the risk characterization. This section provides the estimation of potential exposure to surface soil ECOPCs for the receptors identified in Section 7.0 and Table 8.1. Details of the two exposure models, concentration-based exposure and dosage-based exposure, are presented in Appendix A, Volume 2 of the RI/FS Report.

### **8.1 Exposure Point Concentrations**

Surface soil EPCs for all non-PMJM receptors were calculated using both Tier 1 and Tier 2 methods as described in the Appendix A, Volume 2 of the RI/FS Report. The 30-acre grid used for the Tier 2 calculations is shown on Figure 8.1. The Tier 1 and Tier 2 UTLs and UCLs are presented in Table 8.2. The methodology for the calculation of Tier 2 statistics is provided in Appendix A, Volume 2 of the RI/FS Report.

Surface water EPCs consisted of values that corresponded to the soil EPCs (only for the soil ECOPCs) being used and are used to estimate the total exposure via the surface water ingestion pathway. For example, if the soil EPC statistic was the UCL, then the UCL concentration in surface water (total values only) was selected as the EPC. Surface water EPCs for all ECOPCs were calculated as described for soils and are presented in Table 8.3. All surface water data are provided on the CD in Attachment 6.

### **8.2 Receptor-Specific Exposure Parameters**

Receptor-specific exposure factors are needed to estimate exposure to ECOPCs for each representative species. These include body weight; food, water, and media ingestion rates; and diet composition and respective proportion of each dietary component. Daily rates for intake of forage, prey, water, and incidental ingestion of soils were developed in the CRA Methodology and are presented in Table 8.4 for the receptors of potential concern carried forward in the ERA for the LWNEU.

### 8.3 Bioaccumulation Factors

The measurement or estimation of concentrations of ECOPCs in wildlife food is necessary to evaluate how much of a receptor's exposure is via food versus direct uptake of contaminated media. Conservative BAFs were identified in the CRA Methodology. These BAFs are either simple ratios between chemical concentrations in biota and soil or are based on quantitative relationships such as linear, logarithmic, or exponential equations. The values reported in the CRA Methodology are used as the BAFs for purposes of risk estimation.

### 8.4 Intake and Exposure Estimates

Intake and exposure estimates were completed for each ECOPC/receptor pair identified in Table 8.1. The estimates use the default exposure parameters and BAFs presented in Appendix B of the CRA Methodology and described in the previous subsection. These intake calculations represent conservative estimates of food tissue concentrations calculated from the range of upper-bound EPCs including the Tier 1 and Tier 2 UTLs and UCLs.

#### *Non-PMJM Receptors*

The intake and exposure estimates for ECOPC/non-PMJM receptor pairs are presented in Attachment 4. A summary of the exposure estimates for 4,4'-DDT (American kestrel and insectivorous mourning dove) is presented in Table 8.5.

#### *PMJM Receptors*

No ECOPC/PMJM receptor pairs were identified in Section 7. No further evaluations are conducted.

## 9.0 ECOLOGICAL TOXICITY ASSESSMENT

Exposure to wildlife receptors was estimated for representative species of functional groups based on taxonomy and feeding behavior in Section 8.0 in the form of a daily rate of intake for each ECOPC/receptor pair. To estimate risk, soil concentrations (plants and invertebrate exposure) and calculated intakes (birds and mammals) must then be compared to the toxicological properties of each ECOPC. The laboratory-based toxicity benchmarks are termed toxicity reference values (TRVs) and are of several basic types. The NOAEL and no observed effect concentration (NOEC) TRVs are intake rates or soil concentrations below which no ecologically significant effects are expected. The NOAEL and NOEC TRVs were used to calculate the NOAEL ESLs employed in screening steps of the ECOPC identification process to eliminate chemicals that have no potential to cause risk to the representative receptors. The lowest observed adverse effects level (LOAEL) TRV is a concentration above which the potential for some ecologically significant adverse effect could be elevated. The threshold TRVs represent the hypothetical dose at which the response for a group of exposed organisms may first begin to be significantly greater than the response for unexposed receptors and is calculated as

the geometric mean of the NOAEL and LOAEL. Threshold TRVs were calculated based on specific data quality rules for use in the ECOPC identification process for a small subset of ECOIs in the CRA Methodology.

TRVs for ECOPCs identified for the LWNEU were obtained from the CRA Methodology. The pertinent TRVs for the LWNEU are presented for birds in Table 9.1.

## 10.0 ECOLOGICAL RISK CHARACTERIZATION

Risk characterization includes risk estimation and risk description. Details of these components are described in the CRA Methodology and Appendix A, Volume 2 of the RI/FS Report. Predicted risks should be viewed in terms of the potential for the assumptions used in the risk characterization to occur in nature, the uncertainties associated with the assumptions, and in the potential for effects on the population of receptors that could inhabit the LWNEU.

Potential risks to terrestrial plants, invertebrates, birds, and mammals are evaluated using a hazard quotient (HQ) approach. A HQ is the ratio of the estimated exposure of a receptor to a TRV that is associated with a known level of toxicity, either a no effect level (NOAEL or NOEC) or an effect level (LOAEL or lowest effects concentration [LOEC]):

$$\text{HQ} = \text{Exposure} / \text{TRV}$$

As described in Section 8.0, the units used for exposure and TRV depend upon the type of receptor evaluated. For plants and invertebrates, exposures and TRVs are expressed as concentrations (mg/kg soil). For birds and mammals, exposures and TRVs are expressed as ingested doses (mg/kg/BW/day). In general, if the NOAEL-based HQ is less than 1, then no adverse effects are predicted. If the LOAEL-based HQ is less than 1 but the NOAEL-based HQ is above 1, then some adverse effects are possible, but it is expected that the magnitude and frequency of the effects will usually be low (assuming the magnitude and severity of the response at the LOAEL are not large and the endpoint of the LOAEL accurately reflects the assessment endpoints for that receptor). If the LOAEL-based HQ is greater than or equal to 1, the risk of an adverse effect is of potential concern, with the probability and/or severity of effect tending to increase as the value of the HQ increases.

When interpreting HQ results for non-PMJM ecological receptors, it is important to remember that the assessment endpoint to non-PMJM receptors is based on the sustainability of exposed populations, and risks to some individuals in a population may be acceptable if the population is expected to remain healthy and stable. For threatened and endangered species, such as the PMJM, the interpretation of HQ results is based on potential risks to individuals rather than populations.

HQs were calculated for each ECOPC/receptor pair based on the exposures estimated and TRVs presented in the preceding sections. Risks are discussed and presented to put the assumptions of the risk predictions into context that can be used to make risk management decisions.

## 10.1 Chemical Risk Characterization

Chemical risk characterization utilizes quantitative methods to evaluate potential risks to ecological receptors. In this risk assessment, the quantitative method used to characterize chemical risk is the HQ approach. As noted above, HQs are usually interpreted as follows:

HQ Values		Interpretation of HQ Results
NOAEL-based	LOAEL-based	
$\leq 1$	$\leq 1$	Minimal or no risk
$> 1$	$\leq 1$	Low level risk <sup>a</sup>
$> 1$	$> 1$	Potentially significant risk

<sup>a</sup> Assuming magnitude and severity of response at LOAEL are relatively small and based on endpoints appropriate for the assessment endpoint of the receptor considered.

One potential limitation of the HQ approach is that calculated HQ values may sometimes be uncertain due to simplifications and assumptions in the underlying exposure and toxicity data used to derive the HQs. Where possible, this risk assessment provides information on three potential sources of uncertainty, described below.

- **Exposure Point Concentrations (EPCs).** Because surface soil sampling programs in the EU sometimes tended to focus on areas of potential contamination (IHSS/PAC/UBCs), EPCs calculated using the Tier 1 approach (which assumes that all samples are randomly spread across the EU and are weighted equally) may tend to yield an EPC that is biased high. For this reason, a Tier 2 area-weighting approach was used to derive additional EPCs that help compensate for this potential bias. HQs were always calculated based on both Tier 1 and Tier 2 EPCs for non-PMJM receptors. No Tier 2 EPCs were calculated for PMJM receptors due to the limited size of their habitat.
- **Bioaccumulation Factors (BAFs).** For wildlife receptors, concentrations of contaminants in dietary items were estimated from surface soil using uptake equations. When the uptake equation was based on a simple linear model (e.g.,  $C_{\text{tissue}} = \text{BAF} * C_{\text{soil}}$ ), the default exposure scenario used a high-end estimate of the BAF (the 90th percentile BAF). However, the use of high-end BAFs may tend to overestimate tissue concentrations in some dietary items. In order to estimate more typical tissue concentrations, where necessary, an alternate exposure scenario calculated total chemical intake using a 50th percentile (median) BAF and HQs were calculated. The use of the median BAF is

consistent with the approach used in the ecological soil screening level (EcoSSL) guidance (EPA 2005).

- **Toxicity Reference Values (TRVs).** The CRA Methodology utilized an established hierarchy to identify the most appropriate default TRVs for use in the ECOPC selection. However, in some instances, the default TRV selected may be overly conservative with regard to characterizing population-level risks. The determination of whether the default TRVs are thought to yield overly conservative estimates of risk is addressed in the uncertainty sections below on a chemical-by-chemical basis. When an alternate TRV is identified, the chemical-specific uncertainty sections provide a discussion of why the alternate TRV is thought to be appropriate to provide an alternative estimate of toxicity (e.g., endpoint relevance, species relevance, data quality, chemical form, etc.), and HQs were calculated using both default and alternate TRVs where necessary.

The influences of each of these uncertainties on the calculated HQs were evaluated both alone and in concert in the risk description for each chemical. Uncertainties related to the BAFs, TRVs and background risk are presented for each chemical in Attachment 5. Where uncertainties were deemed to be high, Attachment 5 provided alternative BAFs and/or TRVs as appropriate based on the results of the uncertainty assessment.

HQs calculated using the default BAFs and HQs with the Tier 1 and Tier 2 EPCs are provided in Table 10.1 for each ECOPC/Receptor pair. Where no LOAEL HQs exceed 1 using the default exposure and toxicity values, no further HQs were calculated regardless of the results of the uncertainty analysis. Since the default HQs are generally the most conservative risk estimations, if low risk is estimated using these values then further reductions of conservatism would only serve to reduce risk estimates further.

For non-PMJM receptors, where LOAEL HQs greater than 1 are calculated using default assumptions, and the uncertainty analysis indicated that alternative BAFs and/or TRVs would be beneficial to reduce uncertainty and conservatism, alternative HQs are presented in Table 10.1 as appropriate.

The selection of which EPC (e.g., UTL or UCL) is of primary importance will depend upon the type of receptor and the relative home range size. Only the UTL EPC is provided in Table 10.1 for small home range receptors and only the UCL is provided for large home range receptors.

All calculated exposure estimates and HQ values are also provided in Attachment 4. These include the default and alternative HQs and are calculated using a range of EPCs. The results for each ECOPC are discussed in more detail below.

The risk description incorporates results of the risk estimates along with the uncertainties associated with the risk estimations and other lines of evidence to evaluate potential chemical effects on ecological receptors in the LWNEU following accelerated actions. Information considered in the risk description includes receptor groups potentially affected, type of TRV exceeded (e.g., NOAEL versus LOAEL), relation of EU

concentrations to other criteria such as EPA EcoSSLs, and risk above background conditions. In addition, other site-specific and regional factors are considered such as the use of a given ECOPC within the EU related to historical RFETS activities, comparison of ECOPC concentrations within the LWNEU to the rest of the RFETS site as it relates to background, and/or comparison to regional background concentrations.

#### **10.1.1 4,4'-DDT**

4,4'-DDT HQs for the American kestrel and mourning dove (insectivore) are presented in Table 10.1. 4,4'-DDT was not identified as an ECOPC in the LWNEU for any other receptors. Figure 10.1 shows the spatial distribution of 4,4'-DDT in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs.

##### ***HQs Calculated to Characterize Uncertainty***

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs and background risks are presented.

For non-PMJM receptors, no receptors had LOAEL HQs greater than 1 using the default exposure assumptions and no alternative HQs were calculated.

Care should, however, be taken to review the chemical specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

##### ***4,4'-DDT Risk Description***

4,4'-DDT was identified as an ECOPC for the American kestrel and mourning dove (insectivore) receptors only. Information on the historical use and a summary of site data and background data is provided in Attachment 3.

##### ***Non-PMJM Receptors – Small Home-Range***

NOAEL HQs calculated using Tier 1 EPCs were greater than 1 for both the American kestrel and mourning dove (herbivore) for the UTL (Table 10.1).

All LOAEL HQs were less than 1 for both receptors. Risks to populations of receptors from exposure to 4,4'-DDT in LWNEU surface soils are, therefore, considered to be low.

4,4'-DDT was detected in only one of four samples, located near the RFETS site boundary, just west of Indiana Street. The other three nondetect sample results for 4,4'-DDT are located upgradient and west of the one detection. The one detection was only slightly above the reporting limit (26 µg/kg versus a reporting limit of 16 µg/kg) and the other three samples were also slightly above the reporting limit (20, 21, and 22 µg/kg) but were not reported as detections. 4,4'-DDT in surface soil has a mean concentration of 14.4 µg/kg and a standard deviation of 7.8 µg/kg. In the adjacent Windblown area, there are 40 sample results for 4,4'-DDT and none showed a detection. Also, there are no detections of 4,4'-DDT in stream sediments in North Walnut Creek, South Walnut Creek, or McKay Ditch (DOE 1996).

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. The summary is based on the single grid cell mean where 4,4'-DDT was detected (Figure 10.1). All other grid cell means were based on nondetected results and were not included in the HQ summary. The NOAEL HQ was greater than 1 for the grid mean, but the LOAEL HQ was less than 1 for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of mourning dove (insectivore) results in low risk from exposure to 4,4'-DDT.

Uncertainties associated with BAFs and TRVs used in the default HQ calculations are discussed in Attachment 5. No significant uncertainties were identified and no alternative HQ calculations were recommended.

In conclusion, risks to the American kestrel and mourning dove (insectivore) are likely to be low from exposure to 4,4'-DDT in surface soils in the LWNEU.

## 10.2 Ecosystem Characterization

An ecological monitoring program has been underway since 1991 when baseline data on wildlife species was gathered (Ebasco 1992). The purpose of this long-term program was to monitor specific habitats to provide a sitewide database from which to monitor trends in the wildlife populations at RFETS. This type of monitoring program provides localized information that can also be used for analysis at a landscape level to monitor the population trends and general health of the RFETS ecosystem. Permanent transects through three basic habitats were run monthly for more than a decade (K-H 2002b). Observations were recorded concerning the abundance, distribution, and diversity of wide-ranging wildlife species, including observations of migratory birds, raptors, coyotes, and deer. Small mammal monitoring occurred through several tasks in the monitoring program. The Ecological Monitoring Program (DOE 1995) established permanent transects for small mammal monitoring in three habitat types: xeric grasslands, mesic grasslands, and riparian habitats. Preble's mouse studies established small mammal trapping in nearly all riparian habitats across the site (K-H 1998a, 1999a, 2000a, 2001a, 2002a).

Migratory birds were tracked during all seasons, but most notably during the breeding season. Over 8 years of bird survey data were collected on 18 permanent transects. Field observations were summarized into species richness and densities by habitat type. Habitats comprised the general categories of grasslands, woodlands and wetlands. However, summaries in annual reports are grouped by habitat types across RFETS and not within EUs because EU boundaries were determined well after the monitoring program had begun. Additionally, wide-ranging animals may use habitat in several EUs and do not recognize EU boundaries.

Summarizing songbird surveys over the breeding season, diversity indices for RFETS for all habitats combined over 8 years of observations (1991, 1993-1999) show a steady state in diversity of bird communities (K-H 2000). Among habitats, results were similar with the exception of an increasing trend in species richness and a decreasing trend in bird densities in woodland habitats. Woodland bird communities consistently show the highest diversity when compared with bird communities in wetlands and grasslands. The decreasing trend can be mostly attributed to transient species (i.e., those species not usually associated with woody cover) except for red-tail hawk (*Buteo jamaicensis*) and American goldfinch (*Carduelis tristis*). The red-tailed hawk change in density can be attributed to a loss of nesting sites in Upper Woman Creek during the survey period. Goldfinch abundance can be heavily influenced by the availability of food sources.

A subgroup of migratory birds is neotropical migrants, which show declining populations in North America (Audubon 2005, Nature Conservancy 2005). Most of this decline is thought to be due to conversion of forest land to agriculture in the tropics, and conversion to real estate development in North America. Grassland birds that are neotropical migrants are also in decline. However, over the last 5 years on RFETS, the declining trends have not been observed and densities for this group show an increase.

Raptors, big game species, and carnivores were observed through relative abundance surveys and multi-species surveys (16 permanent transects) that provide species-specific sitewide counts. Raptors were noted on relative abundance surveys and nest sites were visited repeatedly during the nesting season to confirm nesting success. The three most common raptors at RFETS are red-tailed hawk, great horned owl (*Bubo virginianus*), and American kestrel (*Falco sparverius*) (K-H 2002b). One Swainson's hawk nest in North Walnut Creek near the A-1 Pond, and one great horned owl nest was noted within South Walnut Creek (Ryon 2005). All nests typically fledged two young of each species, except kestrels, which usually fledged two to three young. Each species had a successful nesting season each year during the monitoring period from 1991 to 1999 with one exception. This exception was the loss of the red-tail hawk nest in Upper Woman Creek (K-H 1997a and 1998a) due to weather. The continued presences of nesting raptors at RFETS (K-H 2002b) indicate that habitat quality and protection from human disturbance have contributed to making RFETS a desirable location for raptors to reproduce. Adequate habitat provides essential seasonal requirements. RFETS is estimated to be at optimum population density for raptors given available habitat and territorial nature of these species (K-H 2000).

Two deer species inhabit RFETS, mule deer (*Odocoileus hemionus*) and white-tailed deer (*Odocoileus virginianus*). No white-tailed deer were present at RFETS in 1991 when monitoring began (K-H 2002b). In 2000 (K-H 2001) numbers of white-tailed deer were estimated to be between 10 and 15 individuals. White-tailed deer frequent LWNEU, but spend the majority of their time in LWOEU. Mule deer frequent all parts of RFETS (14 mi<sup>2</sup>) year-round. The RFETS population from winter counts is estimated at a mean 125 individuals (n = 7) with a density of 14 deer per square mile (K-H 2000, 2002b). Winter mule deer counts have varied from 100 to 160 individuals over the monitoring period (1994 to 2000) with expected age/sex class distributions (K-H 2001). The mule deer populations from RFETS have been increasing at a steady state with good age/sex

distributions (K-H 2001) over time and similar densities when compared to other "open" populations that are not hunted. This provides a good indicator that habitat quality is high and that site activities have not affected deer populations. It is unlikely that deer populations are depressed or reproduction is affected by contaminants. A recent study on actinides in deer tissue found that plutonium levels were near or below detection limits (Todd and Sattelberg 2004). This provides further support that the deer population is healthy.

Coyotes (*Canis latrans*) are the top mammalian predator at RFETS. They prey upon mule deer fawns and other smaller prey species. The number of coyotes using the site has been estimated at 14 to 16 individuals (K-H 2002b). Through surveys across the site, coyotes have been noted having reproduction success with as many as six dens active in one year (Nelson 2003). Typically at RFETS, three to six coyote dens support an estimated 14 to 16 individuals at any given time (K-H 2001). No coyote dens have ever been found within the LWNEU likely due to the large amount of human activities associated with pond management. Coyotes have exhibited a steady population over time indicating their prey species continue to be abundant and healthy.

The LWNEU has been trapped over several years (DOE 1995, K-H 1998, K-H 2001) under the Ecological Monitoring Program. Initially (DOE 1995), two monitoring sites, a mesic grassland and a riparian site, were established for long-term monitoring. Results from this trapping effort revealed typical small mammal communities with normal densities of each species (DOE 1995, Fitzgerald et al. 1994). Preble's mice (*Zapus hudsonius preblei*) have been captured in LWNEU over the last decade (DOE 1995, K-H 1998, 2000) and have persisted at expected densities over time. Common species found in riparian areas have also been captured with Preble's mice indicating a typical community of small mammals in the LWNEU. Results of small mammal trapping from 1993 to 2000 give indications of diverse and healthy small mammal communities in the LWNEU and monitoring has revealed abundance and species diversity that would be expected in typical native ecosystems on the plains of Colorado (Fitzgerald et al. 1994).

The high species diversity and continued use of the site by numerous vertebrate species verifies that habitat quality for these species remains acceptable and the ecosystem functions are being maintained (K-H 2000). Data collected on wildlife abundance and diversity indicate that wildlife populations are stable and species richness remains high during remediation activities at RFETS including wildlife using LWNEU.

### 10.3 General Uncertainty Analysis

Quantitative evaluation of ecological risks is limited by uncertainties regarding the assumptions used to predict risk and the data available for quantifying risk. These limitations are usually addressed by making estimates based on the data available or by making assumptions based on professional judgment when data are limited. Because of these assumptions and estimates, the results of the risk calculations themselves are uncertain, and it is important for risk managers and the public to view the results of the risk assessment with this in mind. Chemical-specific uncertainties are presented in Attachment 5 of this document and were discussed in terms of their potential effects on

the risk characterization in the risk description section for each ECOPC. A full discussion of categories of general uncertainty that are not specific to the LWNEU is presented in Appendix A, Volume 2 of the RI/FS Report. The following sections are potential sources of general uncertainty that are specific to the LWNEU ERA.

### **10.3.1 Uncertainties Associated With Data Adequacy and Quality**

Sections 1.2 and 1.3 summarize the general data adequacy and data quality for the LWNEU, respectively. A more detailed discussion is presented in Attachment 2 and Appendix A, Volume 2 of the RI/FS Report. The data adequacy assessment indicates that the data are adequate for the CRA. Data of sufficient quality for ERA purposes were collected in surface and subsurface soils.

### **10.3.2 Uncertainties Associated with the Lack of Toxicity Data for Ecological Contaminant of Interest Detected at the Lower Walnut Drainage Exposure Unit**

Several ECOIs detected in the LWNEU do not have adequate toxicity data for the derivation of ESLs (CRA Methodology). These ECOIs are listed in Tables 7.1, 7.3, and 7.12 with a "UT" designation. Appendix B of the CRA Methodology outlines a detailed search process that was intended to provide high quality toxicological information for a large proportion of the chemicals detected at RFETS. Although the toxicity is uncertain for those ECOIs that do not have ESLs calculated due to a lack of identified toxicity data, the overall effect on the risk assessment is small because the primary chemicals historically used at RFETS have adequate toxicity data for use in the CRA. Therefore, while the potential for risk from these ECOPCs is uncertain and will tend to underestimate the overall risk calculated, the magnitude of underestimation is likely to be low.

ESLs and/or TRVs were not available for some receptors for the ECOPC identified in Section 7. These include plants and invertebrates for 4,4'-DDT. The risks to these ECOPC/receptor pairs is uncertain. The lack of ESLs for some receptors may tend to underestimate potential risks to ecological receptors. However, the magnitude of this underestimation is likely to be low as there are no known RFETS-related sources of 4,4'-DDT in the LWNEU and available ESLs for organics show estimated ecological risks to be minimal to low for those receptors where toxicity information is available. This source of uncertainty is not expected to be significant.

### **10.3.3 Uncertainties Associated With Eliminating Ecological Contaminants of Interest Based on Professional Judgment**

Several analytes in surface soil and subsurface soil were eliminated as ECOIs based on professional judgment. The professional judgment evaluation is intended to identify those ECOIs that have a limited potential for contamination in the LWNEU. The weight-of-evidence approach indicates that there is no identified source or pattern of release in the LWNEU, and the slightly elevated values of the LWNEU data for these ECOIs are most likely due to natural variation. The professional judgment evaluation has little effect on

the overall risk calculations because the ECOIs eliminated from further consideration are not related to site-activities in the LWNEU and have very low potential to be transported from historical sources to the LWNEU.

#### **10.4 Summary of Significant Sources of Uncertainty**

The preceding discussion outlined the significant sources of uncertainty in the CRA process for assessing ecological risk. While some of the sources of uncertainty discussed tend to either underestimate risk or overestimate risk, many result in an unknown effect on the potential risks. However, the CRA process was designed to be of a conservative nature which should be taken into consideration when reviewing the conclusions of the risk assessment.

### **11.0 SUMMARY AND CONCLUSIONS**

A summary of the results of this CRA for human health and ecological receptors in the LWNEU is presented below.

#### **11.1 Human Health**

The COC screening analyses compared MDCs and UCLs of chemicals and radionuclides in LWNEU media to PRGs for the WRW receptor. PCOCs with UCLs greater than the PRGs were statistically compared to the background concentration data set. Inorganic analytes that were statistically greater than background at the 0.1 significance level, and organics with UCL concentrations greater than the PRG were carried forward to professional judgment evaluation. Based on the COC selection process, no COCs were selected for surface soil/surface sediment and subsurface soil/subsurface sediment in the LWNEU and a risk characterization was not performed for the LWNEU.

#### **11.2 Ecological Risk**

The overall conclusions for the ERA suggest that no significant risks to survival, growth, and reproduction is predicted for the ecological receptors evaluated in the LWNEU (see Table 11.1). 4,4'-DDT was the only ECOPC in surface soil identified for non-PMJM receptors. No ECOPCs were identified in subsurface soil. The ECOPC/receptor pairs were evaluated in the risk characterization using a range of EPCs, exposure scenarios, and TRVs to give a range of risk estimates.

In addition, the high species diversity and continued use of the site by numerous vertebrate species verify that habitat quality for these species remains acceptable and the ecosystem functions are being maintained (K-H 2000). Data collected on wildlife abundance and diversity indicate that wildlife populations are stable and species richness remains high during remediation activities at RFETS, including wildlife using the LWNEU.

## 12.0 REFERENCES

Audubon, 2005. The Missing Birds of Rock Creek Park. Online article under Issues and Actions. <[http://www.audubon.org/campaign/population\\_habitat](http://www.audubon.org/campaign/population_habitat)>. July.

Beyer, N.M., E.E. Connon, and S. Gerould, 1994. Estimates of Soil Ingestion by Wildlife. *Journal of Wildlife Management*, 58(2):375-382.

Brown, L., and D. Amadon, 1968. *Eagles, Hawks, and Falcons of the World: Volume 1*. New York: McGraw-Hill.

Cal/EPA. 2004. EcoTox Database, Online.  
<<http://www.oehha.ca.gov/ecotox/documents/caleco1.html>>.

Calder, W. A., and E. J. Braun, 1983. Scaling of Osmotic Regulation in Mammals and Birds. *American Journal of Physiology*, 224: R601-R606.

Department of Energy (DOE), 1992a. Final Historical Release Report for Rocky Flats Plant, Golden, Colorado. June.

DOE, 1995. Ecological Monitoring Program. 1995 Annual Report. Rocky Flats Field Office, Rocky Flats Environmental Technology Site. Golden Colorado.

DOE, 1995a. Final Letter Report – Colorado Department of Public Health and Environment Source Area Delineation and Risk-Based Conservative Screen and Environmental Protection Agency Area of Concern Delineation. Rocky Flats Environmental Technology Site OU 11, West Spray Field, Golden, Colorado. June.

DOE, 1995b. Sitewide Geoscience Characterization Study. Volume II: Hydrogeologic Characterization Report for the Rocky Flats Environmental Technology Site, Golden, Colorado. April.

DOE, 1995c. Operable Unit 11 Combined Phases RFI/RI Report for the Rocky Flats Environmental Technology Site Final Report, Golden, Colorado. June.

DOE, 1995d. Ecological Monitoring Program. 1995 Annual Report. Rocky Flats Field Office, Rocky Flats Environmental Technology Site, Golden, Colorado.

DOE, 1996. Final Phase I RFI/RI Report, Woman Creek Priority Drainage, Operable Unit 5, Rocky Flats Environmental Technology Site, Golden, Colorado. April.

DOE, 2002. Final Buffer Zone Sampling and Analysis Plan, Rocky Flats Environmental Technology Site, Golden, Colorado. June.

DOE, 2004. Comprehensive Risk Assessment Sampling and Analysis Plan Addendum, #04-01, Rocky Flats Environmental Technology Site, Golden, Colorado. March.

DOE, 2005a. Final Comprehensive Risk Assessment Work Plan and Methodology, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1. September.

DOE, 2005b. Closeout Report for IHSS Group 900-11, PAC SE-1602, East Firing Range and Target Area, Rocky Flats Environmental Technology Site, Golden, Colorado. March.

Ebasco Environmental Consultants Inc., 1992. Baseline Biological Characterization of the Terrestrial and Aquatic Habitats at Rocky Flats Plant. Prepared for U.S. DOE, Rocky Flats Field Office. Golden, Colorado.

EPA, 1993. Wildlife Exposure Factors Handbook: Volumes I and II.  
EPA/600/R-93/187a. Office of Research and Development, Washington D.C. December.

EPA, 2003. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). OSWER 9285.7-55. Office of Solid Waste and Emergency Response. December.

EPA, 2005. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). Attachment 4-1 Update. Office of Solid Waste and Emergency Response, February.

Fitzgerald, J.P., C.A. Meaney, and D.M. Armstrong. 1994. Mammals of Colorado. University Press of Colorado and Denver Museum of Natural History. 467pp.

K-H, 1997a. 1996 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 1997b. Terrestrial Vegetation Survey (1993-1995) for the Rocky Flats Environmental Technology Site, Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 1998a. 1997 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 1998b. 1997 Study of the Preble's Meadow Jumping Mouse at the Rocky Flats Environmental Technology Site. Appendix B, 1997 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 1998, 1997. Annual Wildlife Report for the Rocky Flats Environmental Technology Site, Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 1999, 1998. Annual Wildlife Report for the Rocky Flats Environmental Technology Site, Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 1999. 1998 Study of the Preble's Meadow Jumping Mouse at the Rocky Flats Environmental Technology Site. Appendix B, 1998 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site, Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2000, 1999. Annual Wildlife Survey for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2000. 1999 Study of the Preble's Meadow Jumping Mouse at the Rocky Flats Environmental Technology Site. Appendix B, 1999 Annual Wildlife Survey for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2001. 2000 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2002, 2001. Annual Wildlife Report for the Rocky Flats Environmental Technology Site, Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2002a. 2001 Annual Vegetation Report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2002b. 2001 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado..

Koplin, J.R., M.W. Collopy, and A.R. Bammann, 1980. Energetics of Two Wintering Raptors. *Auk*, 97:795-806.

National Academy of Sciences (NAS), 2000. Dietary Reference Intake Series 1997-2001, Subcommittees on Upper Reference Levels of Nutrients and Interpretation and Uses of DRIs, Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board. Upper Limits (ULs) Developed from RDIs by the U.S. Food and Drug Administration.

NAS, 2002. Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. Panel on Micronutrients, Subcommittees on Upper Reference Levels of Nutrients and of Interpretation and Use of Dietary Reference Intakes, and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes.

Nature Conservancy, 2005. Migratory Bird Program Online Article. Migratory Birds. <<http://nature.org/initiatives/programs/birds/>>.

Nelson, J., 2003. Senior Ecologist, Kaiser-Hill Ecology Group, Rocky Flats Environmental Technology Site. Personal communication with Bill Mangle, ERO Resources. January 14.

PRC, 1994. Draft Technical Memorandum: Development of Toxicity Reference Values, as Part of a Regional Approach for Conducting Ecological Risk Assessment at Naval Facilities in California. PRC Environmental Management, Inc. Prepared for the U.S. Department of Navy.

PTI, 1997. 1997 Annual Vegetation Report for the Rocky Flats Environmental Technology Site. Prepared by PTI Environmental Services for Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

Ryon, Thomas, 2005. Senior Biologist, Otter/Tail Environmental, Inc., Former Rocky Flats Environmental Technology Site Wildlife Biologist. Personal Communication with Joe Allen, Senior Risk Assessor, Newfields. June.

Todd, A., and M. Sattelberg, 2004. Actinides in Deer Tissue at the Rocky Flats Environmental Technology site. U.S. Fish and Wildlife Service Internal Report.

USFWS, 2004. Rocky Flats National Wildlife Refuge, Final Comprehensive Conservation Plan and Environmental Impact Statement. U.S. Fish and Wildlife Service. September.

## TABLES

**Table 1.1**  
**LWNEU IHSSs**

<b>IHSS</b>	<b>OU</b>	<b>PAC</b>	<b>Title</b>	<b>Description</b>	<b>Disposition</b>
142.12	BZ	NE-142.12	Flume Pond (IAG Name: Newly Identified Pond A-5)	The Flume Pond is associated with two Parshall Flumes used for flow measurement.	Proposed for NFAA in the Final Data Summary Report for IHSS Group NE-1 (in preparation).

216

**Table 1.2**  
**Number of Samples in Each Medium by Analyte Suite**

Analyte Suite	Surface Soil/Surface Sediment <sup>a</sup>	Subsurface Soil/Subsurface Sediment <sup>a</sup>	Surface Soil <sup>b</sup>	Surface Soil (PM <sub>10</sub> ) <sup>b</sup>	Subsurface Soil <sup>b</sup>
Inorganics	29	20	23	10	14
Organics	15	21	12	8	16
Radionuclides	81	17	57	12	11

<sup>a</sup> Used in the HHRA.

<sup>b</sup> Used in the ERA.

Note: The total number of results (samples) in Tables 1.3 through 1.7 may differ from the total number of samples presented in Table 1.2 because not all analyses are necessarily performed for each sample.

**Table 1.3**  
**Summary of Detected Analytes in Surface Soil/Surface Sediment**

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
<b>Inorganics (mg/kg)</b>							
Aluminum	1.07 - 50	25	100	7.460	17,000	11,600	2,490
Antimony	0.25 - 50	17	23.5	0.490	1.00	3.20	3.84
Arsenic	0.14 - 2	25	100	2.20	9.40	5.45	1.56
Barium	0.028 - 40	25	100	86.4	180	126	23.1
Beryllium	0.003 - 5	25	80	0.622	1.30	0.793	0.214
Boron	0.38 - 0.65	18	100	2.75	8.40	4.89	1.43
Cadmium	0.02 - 5	25	80	0.220	2.20	0.900	0.633
Calcium	2.77 - 1,000	25	100	1,160	18,000	5,640	3,680
Chromium	0.064 - 10	28	100	6.90	21.0	13.3	3.49
Cobalt	0.083 - 10	28	100	4.30	11.0	7.67	1.52
Copper	0.05 - 10	28	100	5.00	22.0	13.9	3.22
Iron	0.251 - 20	28	100	9,520	81,700	18,126	13,535
Lead	0.16 - 2	28	100	13.0	50.9	23.8	9.79
Lithium	0.003 - 20	28	100	4.80	17.0	9.87	2.96
Magnesium	0.576 - 1,000	28	100	1,490	4,200	2,512	597
Manganese	0.041 - 10	28	100	130	1,110	286	175
Mercury	0.003 - 0.2	28	53.6	0.013	0.036	0.031	0.019
Molybdenum	0.13 - 40	28	64.3	0.202	5.30	1.14	1.33
Nickel	0.141 - 20	28	96.4	7.00	22.0	14.0	3.14
Nitrate / Nitrite	0.05 - 1	4	50	0.880	2.50	1.75	0.671
Potassium	2.03 - 1,000	28	100	1,490	3,400	2,289	572
Selenium	0.24 - 2	28	7.14	0.660	0.780	0.386	0.232
Silica	2.38 - 5.1	17	100	710	2,000	1,138	376
Silicon	4.1 - 100	5	100	283	1,970	1,285	634
Silver	0.075 - 10	28	39.3	0.167	1.31	0.602	0.497
Sodium	1.68 - 1,000	28	53.6	26.9	790	146	186
Strontium	0.021 - 40	28	100	23.4	95.0	47.3	16.5
Thallium	0.33 - 2	28	7.14	0.610	0.678	0.373	0.174
Tin	0.217 - 100	28	35.7	0.289	93.3	6.87	17.9
Titanium	0.025 - 0.11	21	100	42.0	150	90.2	30.5
Vanadium	0.054 - 10	28	100	20.9	52.0	34.0	8.04
Zinc	0.055 - 10	28	100	36.7	130	60.0	18.2
<b>Organics (µg/kg)</b>							
1,4-Dichlorobenzene <sup>b</sup>	5.8 - 340	15	53.3	0.450	1.50	107	82.7
2-Butanone	10 - 128	11	18.2	25.0	38.0	50.2	5.99
4,4'-DDT	16 - 16	7	14.3	26.0	26.0	13.3	1.80
Acetone	10 - 128	11	9.09	210	210	81.7	3.82
Benzoic Acid	1,600 - 1,700	7	85.7	220	500	380	6.68
bis(2-ethylhexyl)phthalate	330 - 340	7	57.1	49.0	130	138	77.1
delta-BHC	8 - 8.1	7	14.3	23.0	23.0	8.01	45.8
Di-n-butylphthalate	330 - 340	7	14.3	38.0	38.0	209	5.99
Methylene Chloride	5 - 6.4	11	18.2	1.80	3.10	4.85	19.3
Phenol	330 - 340	7	14.3	110	110	206	120
Tetrachloroethene	5 - 6.4	11	54.5	0.380	0.420	1.85	229
Toluene	5 - 6.4	11	27.3	6.00	18.0	6.01	57.5
<b>Radionuclides (pCi/g)</b>							
Americium-241	0.002 - 0.564	71	N/A	-0.022	0.336	0.064	0.070
Cesium-134	0.064 - 0.1	5	N/A	0.002	0.110	0.024	0.048
Cesium-137	0.04 - 0.14	10	N/A	0.004	1.25	0.597	0.497
Gross Alpha	1 - 30	11	N/A	-2.40	28.3	14.6	8.22
Gross Beta	2 - 20	11	N/A	8.45	33.8	24.2	7.03
Plutonium-239/240	0 - 0.2804	77	N/A	-0.012	1.02	0.164	0.227
Radium-226	0.17 - 0.336	8	N/A	0.510	1.16	0.813	0.250
Radium-228	0.07 - 0.07	1	N/A	0.930	0.930	0.930	N/A
Strontium-89/90	0.26 - 0.3	4	N/A	-0.013	0.240	0.119	0.129
Uranium-233/234	0.00766 - 0.517	41	N/A	0.351	1.47	0.894	0.249
Uranium-235	0 - 0.602	41	N/A	-0.093	0.196	0.055	0.063
Uranium-238	0 - 0.374	41	N/A	0	1.44	0.868	0.293

<sup>a</sup> For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

<sup>b</sup> All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

<sup>c</sup> All radionuclide values are considered detects.

N/A = Not applicable.

**Table 1.4**  
**Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment**

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
<b>Inorganics (mg/kg)</b>							
Aluminum	0.957 - 40	20	100	3,760	17,000	10,257	3,872
Arsenic	0.26 - 2	20	100	2.50	12.8	5.18	2.44
Barium	0.025 - 40	20	100	73.6	170	119	26.9
Beryllium	0.003 - 3.35	20	75	0.570	1.30	0.725	0.241
Boron	0.341 - 0.392	9	100	3.67	6.40	4.46	0.899
Calcium	1.5 - 1,000	20	100	3,450	11,400	6,426	2,291
Cesium <sup>b</sup>	94 - 200	11	9.09	1.67	1.67	12.7	18.1
Chromium	0.057 - 2	20	100	3.80	18.0	11.8	4.19
Cobalt	0.074 - 10	20	100	4.60	21.1	9.15	3.57
Copper	0.102 - 5	20	100	8.10	18.4	13.6	3.06
Iron	0.225 - 20	20	100	11,300	26,900	16,085	3,930
Lead	0.244 - 2.8	20	100	7.20	24.2	15.6	3.63
Lithium	0.003 - 20	20	100	3.40	14.6	8.54	3.13
Magnesium	0.516 - 1,000	20	100	1,170	4,860	2,777	793
Manganese	0.037 - 3	20	100	120	706	277	134
Mercury	0.003 - 0.1	20	45	0.011	0.089	0.034	0.020
Molybdenum	0.117 - 40	20	15	1.20	7.70	1.38	1.83
Nickel	0.126 - 8	20	100	7.40	24.7	15.7	4.01
Nitrate / Nitrite	0.5 - 0.5	5	20	2.00	2.00	1.42	0.646
Potassium	1.82 - 1,000	20	100	870	2,700	1,518	442
Selenium	0.15 - 1.3	20	20	0.300	0.720	0.348	0.169
Silica <sup>b</sup>	2.13 - 6.7	9	100	428	1,700	661	409
Silicon <sup>b</sup>	0 - 0	1	100	65.0	65.0	65.0	N/A
Silver	0.067 - 2	20	20	0.914	1.50	0.517	0.468
Sodium	1.51 - 1,000	20	95	53.0	1,060	193	221
Strontium	0.019 - 400	20	100	21.9	74.7	50.2	12.8
Thallium	0.34 - 2	20	35	0.210	0.690	0.292	0.149
Tin	0.195 - 40	20	40	0.528	0.736	5.34	9.16
Titanium <sup>b</sup>	0.022 - 0.21	9	100	70.0	113	88.7	15.9
Uranium	1.77 - 11	9	11.1	10.5	10.5	2.49	3.36
Vanadium	0.048 - 10	20	100	17.2	39.0	28.7	6.33
Zinc	0.049 - 4	20	100	38.5	70.0	52.8	9.53
<b>Organics (µg/kg)</b>							
1,4-Dichlorobenzene <sup>b</sup>	5.5 - 330	13	13	61.5	0.270	0.620	121
2-Butanone	10 - 124	18	19	10.5	8.00	51.0	25.7
Acetone	10 - 124	20	21	19.0	3.00	130	32.1
Benzoic Acid	1,600 - 1,600	5	5	60.0	170	480	445
Benzyl Alcohol	330 - 330	5	5	20.0	41.0	41.0	94.3
bis(2-ethylhexyl)phthalate	330 - 330	5	5	60.0	68.0	170	76.5
Di-n-butylphthalate	330 - 330	5	5	20.0	45.0	45.0	92.6
Methylene Chloride	5 - 6.2	20	21	52.4	2.60	18.0	3.81
Toluene	5 - 6.2	20	21	38.1	3.00	120	26.4
<b>Radionuclides (pCi/g)</b>							
Americium-241	0 - 0.119	17	N/A	0	0.850	0.086	0.202
Cesium-134	0.0335 - 0.2	7	N/A	-0.077	0.200	0.062	0.114
Cesium-137	0.0338 - 0.2	10	N/A	-0.017	0.200	0.066	0.083
Gross Alpha	1.6 - 20.1	14	N/A	9.60	30.3	19.4	6.30
Gross Beta	2.7 - 18.9	12	N/A	0	30.7	22.4	8.07
Plutonium-239/240	0 - 0.103	17	N/A	0.002	2.30	0.240	0.556
Radium-226	0.3 - 0.735	5	N/A	0.600	1.20	0.864	0.217
Radium-228	0.134 - 0.74	4	N/A	1.10	1.30	1.19	0.086
Strontium-89/90	0.0554 - 0.6	6	N/A	-0.027	0.470	0.162	0.179
Uranium-233/234	0.019 - 0.2	13	N/A	0.512	1.30	0.966	0.219
Uranium-235	0 - 0.2	13	N/A	0.007	0.110	0.051	0.031
Uranium-238	0 - 0.182	13	N/A	0.542	1.25	0.965	0.212

<sup>a</sup> For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

<sup>b</sup> All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

<sup>c</sup> All radionuclide values are considered detects.

N/A = Not applicable.

29

**Table 1.5**  
**Summary of Detected Analytes in Surface Soil**

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration <sup>a</sup>	Standard Deviation
<b>Inorganics (mg/kg)</b>							
Aluminum	1.07 - 50	22	100	7,460	17,000	11,900	2,420
Antimony <sup>b</sup>	0.25 - 50	14	28.6	0.490	1.00	2.10	2.87
Arsenic	0.291 - 2	22	100	2.20	9.40	5.68	1.52
Barium	0.028 - 10	22	100	86.4	180	126	23.0
Beryllium	0.003 - 5	22	100	0.622	1.30	0.836	0.185
Boron	0.38 - 0.65	22	100	2.75	8.40	4.89	1.43
Cadmium	0.02 - 5	22	90.9	0.220	2.20	0.933	0.666
Calcium	2.77 - 1,000	22	100	1,160	18,000	5,340	3,580
Chromium	0.064 - 10	22	100	7.92	21.0	13.4	2.97
Cobalt	0.083 - 10	22	100	4.30	11.0	7.52	1.38
Copper	0.05 - 10	22	100	5.00	17.5	13.4	2.68
Iron	0.251 - 20	22	100	9,520	81,700	18,900	15,100
Lead	0.16 - 2	22	100	13.3	50.9	25.8	10.1
Lithium	0.003 - 10	22	100	4.80	16.0	9.86	2.54
Magnesium	0.576 - 1,000	22	100	1,490	3,400	2,420	493
Manganese	0.041 - 10	22	100	170	1,110	301	193
Mercury	0.003 - 0.2	22	68.2	0.013	0.036	0.031	0.019
Molybdenum	0.13 - 20	22	68.2	0.202	5.30	0.967	1.26
Nickel	0.141 - 20	22	100	7.00	22.0	14.0	3.02
Nitrate / Nitrite	0.05 - 0.05	1	100	0.880	0.880	0.880	N/A
Potassium	2.03 - 1,000	22	100	1,550	3,400	2,320	523
Selenium	0.3 - 2	22	9.09	0.660	0.780	0.339	0.181
Silica	2.38 - 5.1	14	100	710	1,670	1,050	316
Silicon <sup>b</sup>	100 - 100	4	100	1,150	1,970	1,540	344
Silver	0.075 - 10	22	40.9	0.167	1.31	0.521	0.508
Sodium	1.68 - 1,000	22	45.5	26.9	560	103	136
Strontium	0.021 - 5	22	100	23.4	82.0	43.7	13.1
Thallium	0.33 - 2	22	4.55	0.678	0.678	0.344	0.148
Tin	0.217 - 100	22	40.9	0.289	93.3	6.56	19.9
Titanium <sup>b</sup>	0.025 - 0.11	18	100	42.0	150	88.0	31.4
Vanadium	0.054 - 10	22	100	20.9	52.0	34.4	8.11
Zinc	0.055 - 10	22	100	43.0	77.5	56.1	10.0
<b>Organics (µg/kg)</b>							
1,4-Dichlorobenzene <sup>b</sup>	5.8 - 330	12	66.7	0.450	1.50	72.2	106
4,4'-DDT	16 - 16	4	25.0	26.0	26.0	14.4	7.76
Benzoic Acid	1,600 - 1,600	4	100	220	330	268	51.9
bis(2-ethylhexyl)phthalate	330 - 330	4	25.0	49.0	49.0	174	83.4
delta-BHC	8 - 8	4	25.0	23.0	23.0	9.63	8.92
Methylene Chloride <sup>b</sup>	5.8 - 6.4	8	25.0	1.80	3.10	2.86	0.441
Tetrachloroethene	5.8 - 6.4	8	75.0	0.380	0.420	1.05	1.19
<b>Radionuclides (pCi/g)</b>							
Americium-241	0.008 - 0.254	48	N/A	-0.022	0.295	0.054	0.061
Cesium-134	0.064 - 0.079	4	N/A	0.002	0.005	0.003	0.001
Cesium-137	0.083 - 0.14	7	N/A	0.100	1.25	0.802	0.449
Gross Alpha	1 - 30	8	N/A	8.20	18.1	13.9	3.97
Gross Beta	2 - 20	8	N/A	17.0	33.8	25.5	5.59
Plutonium-239/240	0.003 - 0.2804	53	N/A	-0.012	1.02	0.160	0.239
Radium-226	0.17 - 0.336	7	N/A	0.510	1.16	0.782	0.253
Strontium-89/90	0.3 - 0.3	3	N/A	-0.013	0.240	0.149	0.141
Uranium-233/234	0.0441 - 0.517	19	N/A	0.351	1.18	0.818	0.207
Uranium-235	0.028 - 0.602	19	N/A	-0.093	0.196	0.045	0.083
Uranium-238	0.052 - 0.374	19	N/A	0.455	1.19	0.837	0.214

<sup>a</sup> For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

<sup>b</sup> All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

<sup>c</sup> All radionuclide values are considered detects.

N/A = Not applicable.

30

**Table 1.6**  
**Summary of Detected Analytes in Surface Soil (PMJM Habitat)**

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration <sup>a</sup>	Standard Deviation
<b>Inorganics (mg/kg)</b>							
Aluminum	1.07 - 4.2	9	100	8,030	17,000	12,019	2,495
Arsenic	0.291 - 0.94	9	100	4.8	8.1	5.74	1.11
Barium	0.028 - 0.43	9	100	86.4	180	133	24
Beryllium	0.003 - 0.025	9	100	0.622	1.1	0.77	0.14
Boron	0.38 - 0.59	9	100	2.75	5.73	4.64	0.83
Cadmium	0.02 - 0.075	9	100	0.35	1.7	1.43	0.41
Calcium	2.77 - 4	9	100	2,730	5,840	4,784	974
Chromium	0.064 - 0.18	9	100	7.92	21	13.1	3.68
Cobalt	0.083 - 0.21	9	100	5.49	9.34	7.79	1.06
Copper	0.053 - 0.131	9	100	11.6	17.5	14.36	1.92
Iron	0.251 - 1.6	9	100	10,800	23,000	16,411	3,538
Lead	0.272 - 0.312	9	100	13.3	29	17.8	4.53
Lithium	0.003 - 0.075	9	100	7.87	16	11.3	2.46
Magnesium	0.576 - 2.3	9	100	1,490	3,400	2,631	576
Manganese <sup>b</sup>	0.041 - 0.2	9	100	175	400	268	65.1
Mercury	0.003 - 0.0059	9	100	0.02	0.036	0.03	0.005
Molybdenum	0.13 - 0.34	9	100	0.202	1.09	0.46	0.33
Nickel	0.141 - 0.23	9	100	11.3	18.2	15.3	2.05
Nitrate / Nitrite	0.05 - 0.05	1	100	0.88	0.88	0.88	N/A
Potassium <sup>b</sup>	2.03 - 25	9	100	1,610	3,100	2,077	442
Silica	2.38 - 5	9	100	800	1,670	1,214	272
Silver	0.075 - 0.091	9	78	0.167	1.31	0.54	0.49
Sodium	1.68 - 110	9	89	26.9	52.2	38.6	9.79
Strontium	0.021 - 0.068	9	100	30.3	56	44.8	7.82
Thallium	0.552 - 1.1	9	11	0.678	0.678	0.37	0.14
Tin	0.217 - 0.98	9	89	0.289	0.638	0.52	0.12
Titanium <sup>b</sup>	0.025 - 0.1	9	100	54.5	150	90.5	25.8
Vanadium <sup>b</sup>	0.054 - 0.54	9	100	21.5	52	31.6	8.72
Zinc	0.055 - 0.53	9	100	44.3	64.7	54.3	7.04
<b>Organics (µg/kg)</b>							
1,4-Dichlorobenzene <sup>b</sup>	5.8 - 6.4	8	100	1.8	3.1	2.86	0.44
Methylene Chloride <sup>b</sup>	5.8 - 6.4	8	25	1.8	3.1	2.86	0.44
Tetrachloroethene	5.8 - 6.4	8	75	0.38	0.42	1.05	1.19
<b>Radionuclides (pCi/g)<sup>c</sup></b>							
Americium-241	0.008 - 0.254	12	N/A	-0.0128	0.122	0.04	0.04
Cesium-137	0.1 - 0.14	2	N/A	0.26	0.85	0.56	0.42
Gross Alpha	2 - 3	2	N/A	8.2	18	13.10	6.93
Gross Beta	4 - 4	2	N/A	22	23	22.50	0.71
Plutonium-239/240	0.003 - 0.266	12	N/A	0.0056	0.285	0.13	0.09
Radium-226	0.17 - 0.24	2	N/A	0.51	0.67	0.59	0.11
Strontium-89/90	0.3 - 0.3	2	N/A	0.22	0.24	0.23	0.014
Uranium-233/234	0.0441 - 0.449	7	N/A	0.541	1.18	0.84	0.21
Uranium-235	0.028 - 0.602	7	N/A	-0.0435	0.168	0.046	0.079
Uranium-238	0.052 - 0.297	7	N/A	0.6	1.19	0.82	0.18

<sup>a</sup> For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

<sup>b</sup> All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

<sup>c</sup> All radionuclide values are considered detects.

N/A = Not applicable.

31

**Table 1.7**  
**Summary of Detected Analytes in Subsurface Soil**

Analyte	Reported Detection Limit	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
<b>Inorganics (mg/kg)</b>							
Aluminum	0.957 - 40	14	100	5,250	17,000	10,500	3,800
Arsenic	0.26 - 2	14	100	3.10	12.8	5.89	2.59
Barium	0.025 - 40	14	100	73.6	130	109	17.0
Beryllium	0.003 - 3.35	14	92.9	0.570	1.30	0.777	0.232
Boron	0.341 - 0.392	8	100	3.67	5.33	4.22	0.567
Calcium	1.5 - 1,000	14	100	3,450	11,400	5,830	2,140
Cesium	94 - 200	6	16.7	1.67	1.67	20.7	21.8
Chromium	0.057 - 2	14	100	7.50	18.0	12.5	3.76
Cobalt	0.074 - 10	14	100	4.60	21.1	8.73	4.06
Copper	0.102 - 5	14	100	8.10	17.3	12.6	2.58
Iron	0.225 - 20	14	100	11,300	26,900	16,300	4,690
Lead	0.244 - 2.8	14	100	12.7	24.2	15.9	3.06
Lithium	0.003 - 20	14	100	4.90	14.6	8.81	3.08
Magnesium	0.516 - 1,000	14	100	1,850	4,860	2,790	817
Manganese	0.037 - 3	14	100	120	706	285	156
Mercury	0.003 - 0.1	14	64.3	0.011	0.089	0.034	0.023
Molybdenum	0.117 - 40	14	21.4	1.20	7.70	1.15	1.97
Nickel	0.126 - 8	14	100	7.40	24.7	15.7	4.54
Potassium	1.82 - 1,000	14	100	870	2,090	1,460	406
Selenium	0.15 - 1	14	28.6	0.300	0.720	0.360	0.164
Silica	2.13 - 2.45	8	100	428	751	531	133
Silicon	0 - 0	1	100	65.0	65.0	65.0	N/A
Silver	0.067 - 2	14	21.4	0.914	1.50	0.388	0.475
Sodium	1.51 - 1,000	14	92.9	53.0	1,060	195	264
Strontium	0.019 - 400	14	100	36.2	74.7	50.0	11.7
Thallium	0.34 - 2	14	28.6	0.210	0.340	0.247	0.049
Tin	0.195 - 40	14	57.1	0.528	0.736	3.62	9.65
Titanium	0.022 - 0.026	8	100	70.0	113	86.0	14.7
Uranium	1.77 - 1.89	8	12.5	10.5	10.5	2.12	3.39
Vanadium	0.048 - 10	14	100	17.2	36.4	27.8	6.35
Zinc	0.049 - 4	14	100	38.5	55.9	48.5	6.00
<b>Organics (µg/kg)</b>							
1,4-Dichlorobenzene <sup>b</sup>	5.5 - 6.2	8	100	0.270	0.620	0.430	0.129
Acetone	10 - 124	16	18.8	3.00	16.0	32.5	25.6
Methylene Chloride	5 - 6.2	16	62.5	2.60	6.00	3.36	0.905
Toluene	5 - 6.2	16	31.3	17.0	120	16.2	30.0
<b>Radionuclides (pCi/g)</b>							
Americium-241	0.00554 - 0.06	11	N/A	0	0.850	0.113	0.250
Cesium-134	0.0335 - 0.2	5	N/A	-0.077	0.200	0.072	0.136
Cesium-137	0.0338 - 0.2	5	N/A	-0.017	0.200	0.095	0.106
Gross Alpha	2 - 20.1	9	N/A	11.0	30.3	19.4	6.67
Gross Beta	3.68 - 18.9	7	N/A	0	29.6	21.1	10.1
Plutonium-239/240	0.004 - 0.0445	11	N/A	0.002	2.30	0.314	0.690
Radium-226	0.3 - 0.735	5	N/A	0.600	1.20	0.864	0.217
Radium-228	0.134 - 0.74	4	N/A	1.10	1.30	1.19	0.086
Strontium-89/90	0.0554 - 0.6	5	N/A	-0.027	0.470	0.185	0.190
Uranium-233/234	0.0502 - 0.2	7	N/A	0.512	1.30	0.940	0.285
Uranium-235	0.0442 - 0.2	7	N/A	0.007	0.110	0.054	0.039
Uranium-238	0.0285 - 0.1	7	N/A	0.542	1.25	0.961	0.290

<sup>a</sup> For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

<sup>b</sup> All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

<sup>c</sup> All radionuclide values are considered detects.

N/A = Not applicable.

**Table 2.1**  
**Essential Nutrient Screen for Surface Soil/Surface Sediment**

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake <sup>a</sup> (mg/day)	RDA/RDI/AI <sup>b</sup> (mg/day)	UL <sup>b</sup> (mg/day)	Retain for PRG Screen?
Calcium	18,000	1.80	500-1,200	2,500	No
Magnesium	3,400	0.340	80-420	65-110	No
Potassium	3,400	0.340	2,000-3,500	N/A	No
Sodium	560	0.056	500-2,400	N/A	No

<sup>a</sup> Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.

<sup>b</sup> RDA/RDI/AI/UL taken from NAS 2000, 2002.

N/A = Not available.

**Table 2.2**  
**PRG Screen for Surface Soil/Surface Sediment**

Analyte	PRG <sup>a</sup>	MDC	MDC Exceeds PRG?	UCL <sup>b</sup>	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
<b>Inorganics (mg/kg)</b>						
Aluminum	24,800	21,000	No	—	—	No
Antimony	44.4	1.00	No	—	—	No
Arsenic	<b>2.41</b>	<b>9.40</b>	<b>Yes</b>	<b>5.79</b>	<b>Yes</b>	<b>Yes</b>
Barium	2,870	220	No	—	—	No
Beryllium	100	1.30	No	—	—	No
Boron	9,480	11.0	No	—	—	No
Cadmium	91.4	2.20	No	—	—	No
Chromium <sup>c</sup>	28.4	21.0	No	—	—	No
Cobalt	122	11.0	No	—	—	No
Copper	4,440	22.0	No	—	—	No
Iron	33,300	81,700	Yes	22,482	No	No
Lead	1,000	50.9	No	—	—	No
Lithium	2,220	17.0	No	—	—	No
Manganese	419	1,110	Yes	342	No	No
Mercury	32.9	0.036	No	—	—	No
Molybdenum	555	5.30	No	—	—	No
Nickel	2,220	22.0	No	—	—	No
Nitrate / Nitrite <sup>d</sup>	178,000	2.50	No	—	—	No
Selenium	555	0.780	No	—	—	No
Silica	N/A	2,000	UT	—	—	UT
Silicon	N/A	1,970	UT	—	—	UT
Silver	555	1.31	No	—	—	No
Strontium	66,700	95.0	No	—	—	No
Thallium	7.78	0.678	No	—	—	No
Tin	66,700	93.3	No	—	—	No
Titanium	170,000	150	No	—	—	No
Vanadium	111	52.0	No	—	—	No
Zinc	33,300	130	No	—	—	No
<b>Organics (µg/kg)</b>						
1,4-Dichlorobenzene	91,300	1.50	No	—	—	No
2-Butanone	4.64E+07	38.0	No	—	—	No
4,4'-DDT	10,900	26.0	No	—	—	No
Acetone	1.00E+08	210	No	—	—	No
Benzoic Acid	3.21E+08	500	No	—	—	No
bis(2-ethylhexyl)phthalate	214,000	130	No	—	—	No
delta-BHC	570	23.0	No	—	—	No
Di-n-butylphthalate	8.01E+06	38.0	No	—	—	No
Methylene Chloride	272,000	3.10	No	—	—	No
Phenol	2.40E+07	110	No	—	—	No
Tetrachloroethene	6,710	0.420	No	—	—	No
Toluene	3.09E+06	18.0	No	—	—	No
<b>Radionuclides (pCi/g)</b>						
Americium-241	7.69	0.336	No	—	—	No
Cesium-134	<b>0.080</b>	<b>0.110</b>	<b>Yes</b>	<b>0.237</b>	<b>Yes</b>	<b>Yes</b>
Cesium-137	<b>0.221</b>	<b>1.25</b>	<b>Yes</b>	<b>0.885</b>	<b>Yes</b>	<b>Yes</b>
Gross Alpha	N/A	28.3	UT	—	—	UT
Gross Beta	N/A	33.8	UT	—	—	UT
Plutonium-239/240	9.80	1.02	No	—	—	No
Radium-226	2.69	1.16	No	—	—	No
<b>Radium-228</b>	<b>0.111</b>	<b>0.930</b>	<b>Yes</b>	<b>N/A</b>	<b>N/A</b>	<b>Yes</b>
Strontium-89/90	13.2	0.240	No	—	—	No
Uranium-233/234	25.3	1.47	No	—	—	No
Uranium-235	1.05	0.196	No	—	—	No
Uranium-238	29.3	1.44	No	—	—	No

<sup>a</sup> The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

<sup>b</sup> UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

<sup>c</sup> The PRG for chromium (VI) is used.

<sup>d</sup> The PRG for nitrate is used.

N/A = Not Available

UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).

— = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

**Bold = Analyte retained for further consideration in the next COC selection step.**

34

Table 2.3  
Statistical Distributions and Comparison to Background for LWNEU<sup>a</sup>

Analyte	Statistical Distribution Testing Results						Background Comparison		
	Background Data Set			LWNEU Data Set			Test	1-p	Retain as PCOC?
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Surface Soil/Surface Sediment									
Arsenic	73	GAMMA	91.8	28	NORMAL	100	WRS	7.89E-05	Yes
Cesium-134	77	NONPARAMETRIC	N/A	5	NONPARAMETRIC	N/A	WRS	0.998	No
Cesium-137	105	NONPARAMETRIC	N/A	10	NORMAL	N/A	WRS	0.638	No
Radium-228	40	GAMMA	N/A	1	N/A	N/A	WRS	N/A	N/A
Subsurface Soil/Subsurface Sediment									
Radium-228	31	GAMMA	N/A	4	NORMAL	N/A	WRS	0.944	No

<sup>a</sup> EU data used for background comparisons do not include data from background locations.

N/A = Not applicable. Background comparison was not performed because background data were not available or detection frequency for an analyte in EU or background data set is less than 20 percent.

**Table 2.4**  
**Essential Nutrient Screen for Subsurface Soil/Subsurface Sediment**

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake <sup>a</sup> (mg/day)	RDA/RDI/AI <sup>b</sup> (mg/day)	UL <sup>b</sup> (mg/day)	Retain for PRG Screen?
Calcium	11,400	1.14	500-1,200	2,500	No
Magnesium	4,860	0.490	80-420	65-110	No
Potassium	2700	0.270	2,000-3,500	N/A	No
Sodium	1,060	0.110	500-2,400	N/A	No

<sup>a</sup> Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.

<sup>b</sup> RDA/RDI/AI/UL taken from NAS 2000, 2002.

N/A = Not available.

**Table 2.5**  
**PRG Screen for Subsurface Soil/Subsurface Sediment**

Analyte	PRG <sup>a</sup>	MDC	MDC Exceeds PRG?	UCL <sup>b</sup>	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
<b>Inorganics (mg/kg)</b>						
Aluminum	285,000	17,000	No	--	--	No
Arsenic	27.7	12.8	No	--	--	No
Barium	33,000	170	No	--	--	No
Beryllium	1,150	1.30	No	--	--	No
Boron	109,000	6.40	No	--	--	No
Cesium	N/A	1.67	UT	--	--	UT
Chromium <sup>c</sup>	327	18	No	--	--	No
Cobalt	1,400	21.1	No	--	--	No
Copper	51,100	18.4	No	--	--	No
Iron	383,000	26,900	No	--	--	No
Lead	1,000	24.2	No	--	--	No
Lithium	25,600	14,600	No	--	--	No
Manganese	4,820	706	No	--	--	No
Mercury	379	0.0890	No	--	--	No
Molybdenum	6,390	7.70	No	--	--	No
Nickel	25,600	24.7	No	--	--	No
Nitrate / Nitrite <sup>d</sup>	2.04E+06	2	No	--	--	No
Selenium	6,390	0.720	No	--	--	No
Silica	N/A	1,700	UT	--	--	UT
Silicon	N/A	65	UT	--	--	UT
Silver	6,390	1.50	No	--	--	No
Strontium	767,000	74.7	No	--	--	No
Thallium	89.4	0.690	No	--	--	No
Tin	767,000	0.736	No	--	--	No
Titanium	1.95E+06	113	No	--	--	No
Uranium	3,830	10.5	No	--	--	No
Vanadium	1,280	39	No	--	--	No
Zinc	383,000	70	No	--	--	No
<b>Organics (µg/kg)</b>						
1,4-Dichlorobenzene	1.05E+06	0.620	No	--	--	No
2-Butanone	5.33E+08	51	No	--	--	No
Acetone	1.15E+09	130	No	--	--	No
Benzoic Acid	3.69E+09	480	No	--	--	No
Benzyl Alcohol	2.76E+08	41	No	--	--	No
bis(2-ethylhexyl)phthalate	2.46E+06	170	No	--	--	No
Di-n-butylphthalate	9.22E+07	45	No	--	--	No
Methylene Chloride	3.13E+06	18	No	--	--	No
Toluene	3.56E+07	120	No	--	--	No
<b>Radionuclides (pCi/g)</b>						
Americium-241	88.4	0.850	No	--	--	No
Cesium-134	0.910	0.200	No	--	--	No
Cesium-137	2.54	0.200	No	--	--	No
Gross Alpha	N/A	30.3	No	--	--	UT
Gross Beta	N/A	30.7	No	--	--	UT
Plutonium-239/240	112	2.30	No	--	--	No
Radium-226	31.0	1.20	No	--	--	No
<b>Radium-228</b>	<b>1.28</b>	<b>1.30</b>	<b>Yes</b>	<b>1.29</b>	<b>Yes</b>	<b>Yes</b>
Strontium-89/90	152	0.470	No	--	--	No
Uranium-233/234	291	1.30	No	--	--	No
Uranium-235	12.1	0.110	No	--	--	No
Uranium-238	337	1.25	No	--	--	No

<sup>a</sup> The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

<sup>b</sup> UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

<sup>c</sup> The PRG for chromium (VI) is used.

<sup>d</sup> The PRG for nitrate is used.

N/A = Not Available

UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

**Bold** = Analyte retained for further consideration in the next COC selection step.

Table 2.6  
Summary of the COC Selection Process

Analyte	MDC Exceeds PRG?	UCL Exceeds PRG?	Detection Frequency > 5% <sup>a</sup>	Exceeds 30X the PRG?	Exceeds Background?	Professional Judgment-Retain?	Retain as COC?
<b>Surface Soil/Surface Sediment</b>							
Arsenic	Yes	Yes	Yes	N/A	Yes	No	No
Iron	Yes	No	--	--	--	--	No
Manganese	Yes	No	--	--	--	--	No
Cesium-134	Yes	Yes	Yes	N/A	No	--	No
Cesium-137	Yes	Yes	Yes	N/A	No	--	No
Radium-228	Yes	Yes	Yes	N/A	N/A <sup>b</sup>	No	No
<b>Subsurface Soil/Subsurface Sediment</b>							
Radium-228	Yes	Yes	Yes	N/A	No	--	No

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

N/A = Not applicable.

<sup>a</sup> All radionuclide values are considered detects.

<sup>b</sup> Only one sample was available for this analyte in subsurface soil/subsurface sediment, therefore the analysis could not be performed.

Table 6.1

Detected PCOCs without PRGs in Each Medium by Analyte Suite<sup>a</sup>

Analyte	Surface Soil/Surface Sediment	Subsurface Soil/Subsurface Sediment
<b>Inorganics</b>		
Cesium	N/A	X <sup>b</sup>
Silica	X	X <sup>b</sup>
Silicon	X	X <sup>b</sup>
<b>Radionuclides</b>		
Gross Alpha	X	X
Gross Beta	X	X

<sup>a</sup> Does not include essential nutrients. Essential nutrients without PRGs were evaluated by comparing estimated intakes to recommended intakes.

<sup>b</sup> All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

N/A = Not Applicable. Analyte not detected or not analyzed.

X = PRG is unavailable.

Table 7.1  
Comparison of MDCs in Surface Soil to NOAA ESLs for Terrestrial Plants, Invertebrates, and Vertebrates in the LWNEU

Analyte	MDC	Terrestrial Plants		Terrestrial Invertebrates		Mourning Dove Herbivore		Mourning Dove Insectivore		American Kestrel		Deer Mouse Herbivore		Deer Mouse Insectivore		Prairie Dog		Mule Deer		Coyote Carnivore		Coyote Generalist		Coyote Insectivore		Terrestrial Receptor		Most Sensitive Receptor	Retain for Further Analysis?		
		NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?			Results	
Inorganics (mg/kg)																															
Aluminum	17,000	50	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Plant	Yes		
Antimony	1	5	No	78	No	N/A	N/A	N/A	N/A	N/A	N/A	10	No	0.90	Yes	19	No	58	No	138	No	13	No	3.85	No	N/A	N/A	Deer Mouse Insectivore	Yes		
Arsenic	9.4	10	No	60	No	20	No	164	No	1,028	No	2.57	Yes	51	No	9.35	Yes	13	No	709	No	341	No	293	No	N/A	N/A	Deer Mouse Herbivore	Yes		
Barium	180	500	No	330	No	159	Yes	357	No	1,317	No	930	No	4,427	No	3,224	No	4,766	No	24,896	No	19,838	No	18,369	No	N/A	N/A	Mourning Dove Herbivore	Yes		
Beryllium	1.3	10	No	40	No	N/A	N/A	N/A	N/A	N/A	N/A	160	No	6.82	No	211	No	896	No	1072	No	103	No	29	No	N/A	N/A	Deer Mouse Insectivore	No		
Boron	8.4	0.5	Yes	N/A	N/A	30	No	115	No	167	No	62	No	422	No	237	No	314	No	929	No	6,070	No	1,816	No	N/A	N/A	Plant	Yes		
Cadmium	2.2	32	No	140	No	28	No	0.71	Yes	15	No	60	No	1.56	Yes	198	No	723	No	1,360	No	51	No	10	No	N/A	N/A	Mourning Dove Insectivore	Yes		
Calcium	18,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT		
Chromium	21	1	Yes	0.40	Yes	25	No	1.34	Yes	14	Yes	281	No	16	Yes	703	No	1,461	No	4,173	No	250	No	69	No	N/A	N/A	Invertebrates	Yes		
Cobalt	11	13	No	N/A	N/A	278	No	87	No	440	No	1,476	No	363	No	2,461	No	7,902	No	3,785	No	2,492	No	1,519	No	N/A	N/A	Plant	No		
Copper	17.5	100	No	50	No	29	No	8.25	Yes	164	No	295	No	605	No	838	No	4,119	No	5,459	No	3,000	No	4,641	No	N/A	N/A	Mourning Dove Insectivore	Yes		
Iron	81,700	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT		
Lead	50.9	110	No	1700	No	50	Yes	12	Yes	96	No	1,344	No	242	No	1,850	No	9,798	No	8,927	No	3,066	No	1,393	No	N/A	N/A	Mourning Dove Insectivore	Yes		
Lithium	16	2	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,882	No	610	No	3,178	No	10,173	No	18,431	No	5,608	No	2,560	No	N/A	N/A	Plant	Yes		
Magnesium	3,400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT		
Manganese	1,110	500	Yes	N/A	N/A	1,032	Yes	2,631	No	9,917	No	486	Yes	4,080	No	1,519	No	2,506	No	14,051	No	10,939	No	19,115	No	N/A	N/A	Prairie Dog	Yes		
Mercury	0.036	0.3	No	0.1	No	0.20	No	1.00E-04	Yes	1.57	No	0.44	No	0.18	No	3.15	No	7.56	No	8.18	No	8.49	No	37	No	N/A	N/A	Mourning Dove Insectivore	Yes		
Molybdenum	5.3	2	Yes	N/A	N/A	44	No	6.97	No	77	No	8.68	No	1.90	Yes	27	No	44	No	275	No	29	No	8.18	No	N/A	N/A	Deer Mouse Insectivore	Yes		
Nickel	22	30	No	200	No	44	No	1.24	Yes	13	Yes	16	Yes	0.43	Yes	38	No	124	No	91	No	6.02	Yes	1.86	Yes	N/A	N/A	Deer Mouse Insectivore	Yes		
Nitrate / Nitrite	0.88	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,478	No	7,647	No	16,233	No	22,660	No	32,879	No	32,190	No	32,879	No	N/A	N/A	Deer Mouse Herbivore	No		
Potassium	3,400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT		
Selenium	0.78	1	No	70	No	1.61	No	1.00	No	8.48	No	0.87	No	0.75	Yes	2.80	No	3.82	No	32	No	12	No	5.39	No	N/A	N/A	Deer Mouse Insectivore	Yes		
Silica	1,670	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT		
Silicon	1,970	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT		
Silver	1.31	2	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT		
Sodium	560	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Plant	No	
Strontium	82	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	940	No	13,578	No	3,519	No	4,702	No	584,444	No	144,904	No	57,298	No	N/A	N/A	N/A	UT		
Thallium	0.678	1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	180	No	7.24	No	204	No	1,039	No	212	No	82	No	31	No	N/A	N/A	Deer Mouse Herbivore	No		
Tin	93.3	50	Yes	N/A	N/A	26	Yes	2.90	Yes	19	Yes	45	Yes	3.77	Yes	81	Yes	242	No	70	Yes	36	Yes	16	Yes	N/A	N/A	Mourning Dove Insectivore	Yes		
Titanium	150	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT		
Vanadium	52	2	Yes	N/A	N/A	503	No	274	No	1,514	No	64	No	30	Yes	84	No	358	No	341	No	164	No	121	No	N/A	N/A	Plant	Yes		
Zinc	77.5	50	Yes	200	No	109	No	0.65	Yes	113	No	171	No	5.29	Yes	1,174	No	2,772	No	16,489	No	3,887	No	431	No	N/A	N/A	Mourning Dove Insectivore	Yes		
Organics (µg/kg)																															
1,4-Dichlorobenzene	1.5	N/A	N/A	20,000	No	N/A	N/A	N/A	N/A	N/A	N/A	1.71E+06	No	57,635	No	5.93E+06	No	8.65E+06	No	251,050	No	250,513	No	249,682	No	N/A	N/A	Invertebrates	No		
4,4'-DDT	26	N/A	N/A	N/A	N/A	226	No	1.20	Yes	3.34	Yes	72,072	No	379	No	175,708	No	374,883	No	1,873	No	1,808	No	1,644	No	N/A	N/A	Mourning Dove Insectivore	Yes		
Benzoic Acid	330	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT		
bis(2-ethylhexyl)phthalate	49	N/A	N/A	N/A	N/A	19,547	No	137	No	398	No	960,345	No	8,071	No	2.76E+06	No	4.93E+06	No	42,305	No	40,167	No	34,967	No	N/A	N/A	Mourning Dove Insectivore	No		
delta-BHC	23	N/A	N/A	N/A	N/A	4,687	No	82	No	212	No	1,009	No	26	No	3425	No	5,125	No	117	No	116	No	112	No	N/A	N/A	Deer Mouse Insectivore	No		
Methylene Chloride	3.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	58,196	No	3,399	No	209,560	No	294,601	No	13,687	No	13,922	No	14,727	No	N/A	N/A	Deer Mouse Insectivore	No		
Tetrachloroethene	0.42	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20,713	No	763	No	72,494	No	105,023	No	3,285	No	3,288	No	3,307	No	N/A	N/A	Deer Mouse Insectivore	No		
Radionuclides (pCi/g)																															
Americium-241	0.2946	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Terrestrial Receptors	No	
Cesium-134	0.005	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT	
Cesium-137	1.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Terrestrial Receptors	No
Gross Alpha	18.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT	
Gross Beta	33.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT	
Plutonium-239/240	1.025	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT	
Radium-226	1.16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A																						

\* Radionuclide ESLs are not receptor-specific. They are considered protective of all terrestrial ecological species.

\* ESLs for chromium were developed based on available toxicity data and are based on Chromium (III) (birds) and Chromium (VI) (plants, invertebrates, and mammals).

N/A = Indicates no ESL was available for that ECOI/receptor pair.

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

**Table 7.2**  
**Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the LWNEU**

Analyte	Terrestrial Plant Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Vertebrate Exceedance?
<b>Inorganics</b>			
Aluminum	Yes	UT	UT
Antimony	No	No	Yes
Arsenic	No	No	Yes
Barium	No	No	Yes
Beryllium	No	No	No
Boron	Yes	UT	No
Cadmium	No	No	Yes
Calcium	UT	UT	UT
Chromium	Yes	Yes	Yes
Cobalt	No	UT	No
Copper	No	No	Yes
Iron	UT	UT	UT
Lead	No	No	Yes
Lithium	Yes	UT	No
Magnesium	UT	UT	UT
Manganese	Yes	UT	Yes
Mercury	No	No	Yes
Molybdenum	Yes	UT	Yes
Nickel	No	No	Yes
Nitrate / Nitrite	UT	UT	No
Potassium	UT	UT	UT
Selenium	No	No	Yes
Silica	UT	UT	UT
Silicon	UT	UT	UT
Silver	No	UT	UT
Sodium	UT	UT	UT
Strontium	UT	UT	No
Thallium	No	UT	No
Tin	Yes	UT	Yes
Titanium	UT	UT	UT
Vanadium	Yes	UT	Yes
Zinc	Yes	No	Yes
<b>Organics</b>			
1,4-Dichlorobenzene	UT	No	No
4,4'-DDT	UT	UT	Yes
Benzoic Acid	UT	UT	UT
bis(2-ethylhexyl)phthalate	UT	UT	No
delta-BHC	UT	UT	No
Methylene Chloride	UT	UT	No

41

**Table 7.2**  
**Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the LWNEU**

Analyte	Terrestrial Plant Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Vertebrate Exceedance?
Tetrachloroethene	UT	UT	No
<b>Radionuclides</b>			
Americium-241	UT	UT	No
Cesium-134	UT	UT	UT
Cesium-137	UT	UT	No
Gross Alpha	UT	UT	UT
Gross Beta	UT	UT	UT
Plutonium-239/240	UT	UT	No
Radium-226	UT	UT	No
Strontium-89/90	UT	UT	No
Uranium-233/234	UT	UT	No
Uranium-235	UT	UT	No
Uranium-238	UT	UT	No

UT - Uncertain toxicity; no ESL available (assessed in Section 10).

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

42

Table 7.3

## Comparison of MDCs in Surface Soil with NOAEL ESLs for the PMJM in the LWNEU

Analyte	MDC	PMJM NOAEL ESL	EPC > PMJM ESL?
<b>Inorganics (mg/kg)</b>			
Aluminum	17,000	N/A	N/A
Arsenic	<b>8.10</b>	<b>2.21</b>	<b>Yes</b>
Barium	180	743	No
Beryllium	1.10	8.16	No
Boron	5.73	52.7	No
Cadmium	1.70	1.75	No
Calcium	5,840	N/A	N/A
<b>Chromium<sup>a</sup></b>	<b>21</b>	<b>19.3</b>	<b>Yes</b>
Cobalt	9.34	340	No
Copper	17.5	95.0	No
Iron	23,000	N/A	N/A
Lead	29	220	No
Lithium	16	519	No
Magnesium	3,400	N/A	N/A
<b>Manganese</b>	<b>400</b>	<b>388</b>	<b>Yes</b>
Mercury	0.0360	0.052	No
Molybdenum	1.09	1.84	No
<b>Nickel</b>	<b>18.2</b>	<b>0.510</b>	<b>Yes</b>
Nitrate / Nitrite	0.880	2,910	No
Potassium	3,100	N/A	N/A
Silica	1,670	N/A	N/A
Silver	1.31	N/A	N/A
Sodium	52.2	N/A	N/A
Strontium	56	833	No
Thallium	0.678	8.64	No
Tin	0.638	4.22	No
Titanium	150	N/A	N/A
<b>Vanadium</b>	<b>52</b>	<b>21.6</b>	<b>Yes</b>
<b>Zinc</b>	<b>64.7</b>	<b>6.41</b>	<b>Yes</b>
<b>Organics (µg/kg)</b>			
1,4-Dichlorobenzene	1.50	70,200	No
Methylene Chloride	3.10	4,010	No
Tetrachloroethene	0.420	926	No
<b>Radionuclides (pCi/kg)</b>			
Americium-241	0.122	3,890	No
Cesium-137	0.850	20.8	No
Gross Alpha	18	N/A	N/A
Gross Beta	23	N/A	N/A
Plutonium-239/240	0.285	6,110	No
Radium-226	0.670	50.6	No
Strontium-89/90	0.240	22.5	No
Uranium-233/234	1.18	4,980	No
Uranium-235	0.168	2,770	No
Uranium-238	1.19	1,580	No

<sup>a</sup> The ESL for chromium VI is used.

N/A = No ESL available.

UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

**Table 7.4**  
**Statistical Distribution and Comparison to Background for Surface Soil (Non-PMJM) in the LWNEU**

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			LWNEU Data Set			Test	1 - p	Retain as ECOI*
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Inorganics (mg/kg)									
Aluminum	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.0296	Yes
Antimony	20	NON-PARAMETRIC	0	14	NON-PARAMETRIC	28.6	N/A	N/A	Yes*
Arsenic	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.770	No
Barium	20	NORMAL	100	22	NORMAL	100	t-Test_N	5.06E-04	Yes
Boron	N/A	N/A	N/A	18	GAMMA	100	N/A	N/A	Yes*
Cadmium	20	NON-PARAMETRIC	65	22	NON-PARAMETRIC	90.9	WRS	0.430	No
Chromium	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.00960	Yes
Copper	20	NON-PARAMETRIC	100	22	NON-PARAMETRIC	100	WRS	0.303	No
Lead	20	NORMAL	100	22	GAMMA	100	WRS	0.995	No
Lithium	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.00152	Yes
Manganese	20	NORMAL	100	22	NON-PARAMETRIC	100	WRS	0.134	No
Mercury	20	NON-PARAMETRIC	40	22	GAMMA	68.2	WRS	1.000	No
Molybdenum	20	NORMAL	0	22	GAMMA	68.2	N/A	N/A	Yes*
Nickel	20	NORMAL	100	22	NORMAL	100	t-Test_N	4.59E-06	Yes
Selenium	20	NON-PARAMETRIC	60	22	NON-PARAMETRIC	9.09	N/A	N/A	Yes*
Tin	20	NORMAL	0	22	NON-PARAMETRIC	40.9	N/A	N/A	Yes*
Vanadium	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.00451	Yes
Zinc	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.0371	Yes
Organics (µg/kg)									
4,4'-DDT	N/A	N/A	N/A	4	NON-PARAMETRIC	25	N/A	N/A	Yes*

\* Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.

N/A = Not applicable. Site and/or background detection frequency less than 20 percent.

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

WRS = Wilcoxon Rank Sum.

t-Test\_N = Student's t-test using normal data.

44

**Table 7.5**  
**Statistical Distributions and Comparison to Background for Surface Soil in PMJM Habitat in the LWNEU**

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			LWNEU Data Set			Test	1 - p	Retain as ECOI?
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
<b>Inorganics (mg/kg)</b>									
Arsenic	20	NORMAL	100	9	NON-PARAMETRIC	100	WRS	0.738	No
Chromium	20	NORMAL	100	9	NORMAL	100	t-Test_N	0.067	Yes
Manganese	20	NORMAL	100	9	NORMAL	100	t-Test_N	0.118	No
Nickel	20	NORMAL	100	9	NORMAL	100	t-Test_N	1.88E-06	Yes
Vanadium	20	NORMAL	100	9	LOGNORMAL	100	WRS	0.144	No
Zinc	20	NORMAL	100	9	NORMAL	100	t-Test_N	0.156	No

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

WRS = Wilcoxon Rank Sum.

t-Test\_N = Student's t-test using normal data.

45

Table 7.6  
Statistical Concentrations in Surface Soil (Non-PMJM) in the LWNEU

Analyte	Total # Samples	UCL Recommended by ProUCL	Distribution Recommended by ProUCL	Mean Detected Concentration	Median Detected Concentration	75th Percentile	95th Percentile	UCL	UTL	MDC
<b>Inorganics (mg/kg)</b>										
Aluminum	22	95% Student's-t UCL	NORMAL	11,912	12,000	13,225	14,995	12,801	16,484	17,000
Antimony	14	99% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	2.10	0.510	4.90	6.61	9.73	6.80	6.80
Barium	22	95% Student's-t UCL	NORMAL	126	130	140	150	134	169	180
Boron	18	95% Approximate Gamma UCL	GAMMA	4.89	4.66	5.23	7.98	5.50	8.40	8.40
Chromium	22	95% Student's-t UCL	NORMAL	13.4	13.7	15	16.3	14.5	19.0	21
Lithium	22	95% Student's-t UCL	NORMAL	9.86	10	11.5	13.0	10.8	14.7	16
Molybdenum	22	95% Approximate Gamma UCL	GAMMA	0.967	0.500	0.960	2.70	1.48	5.30	5.30
Nickel	22	95% Student's-t UCL	NORMAL	14.0	14	15.3	18.2	15.1	19.7	22
Selenium	22	95% Student's-t UCL	NON-PARAMETRIC	0.339	0.250	0.456	0.657	0.406	0.780	0.780
Tin	22	99% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	6.56	0.644	1.05	13.5	48.7	93.3	93.3
Vanadium	22	95% Student's-t UCL	NORMAL	34.4	32.9	38.8	50.6	37.4	49.7	52
Zinc	22	95% Student's-t UCL	NORMAL	56.1	54.7	64.9	71.7	59.8	75.0	77.5
<b>Organics (µg/kg)</b>										
4,4'-DDT	4	95% Student's-t UCL	NON-PARAMETRIC	14.4	10.8	14.8	23.8	23.5	26	26.0

MDC = Maximum detected concentration or in some cases, maximum proxy result.

UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC < UTL, then the MDC is used as the UTL.

Table 7.7

## Upper-Bound Exposure Point Concentration Comparison to Limiting tESLs in the LWNEU Surface Soil (Non-PMJM)

Analyte	Small Home Range Receptors			Large Home Range Receptors		
	EPC (95UFL)	Limiting ESL <sup>a</sup>	EPC>ESL?	EPC (95UCL)	Limiting ESL <sup>b</sup>	EPC>ESL?
<b>Inorganics (mg/kg)</b>						
Aluminum	16,484	50	Yes	12,801	N/A	N/A
Antimony	6.80	0.90	Yes	9.73	3.85	Yes
Barium	169	222	No	134	4,770	No
Boron	8.40	0.5	Yes	5.50	314	No
Chromium <sup>c</sup>	19.0	0.4	Yes	14.5	68.5	No
Lithium	14.7	2	Yes	10.8	2,560	No
Molybdenum	5.30	1.9	Yes	1.48	8.18	No
Nickel	19.7	0.431	Yes	15.1	1.86	Yes
Selenium	0.780	0.75	Yes	0.406	3.82	No
Tin	93.3	2.90	Yes	48.7	16	Yes
Vanadium	49.7	2	Yes	37.4	121	No
Zinc	75.0	0.646	Yes	59.8	431	No
<b>Organics (µg/kg)</b>						
4,4'-DDT	26	1.2	Yes	23.5	1,640	No

<sup>a</sup> Threshold ESL (if available) for the plant, invertebrate, deer mouse, prairie dog, dove, or kestrel receptors.

<sup>b</sup> Threshold ESL (if available) for the coyote and mule deer receptors.

<sup>c</sup> The ESLs for chromium were developed based on available toxicity data and are based on chromium (III) (birds) and chromium (VI) (plants, invertebrates, and mammals).

N/A = Not applicable; ESL not available (assessed in Section 10).

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

Table 7.8

## Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Small Home-Range Receptors in the LWNEU Surface Soil (Non-PMJM)

Analyte	Small Home Range Receptor UTL	Receptor-Specific ESLs							
		Terrestrial Plant	Terrestrial Invertebrate	American Kestrel	Mourning Dove (herbivore)	Mourning Dove (insectivore)	Deer Mouse (herbivore)	Deer Mouse (insectivore)	Prairie Dog
Inorganics (mg/kg)									
Aluminum	16,484	50	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Antimony	6.80	5	78	N/A	N/A	N/A	10	0.90	19
Boron	8.40	0.5	N/A	167	30	115	62	422	237
Chromium	19.0	1	0.4	14.2	24.6	1.34	281	15.9	703
Lithium	14.7	2	N/A	N/A	N/A	N/A	1,880	610	3,180
Molybdenum	5.30	2	N/A	76.7	44.4	6.97	8.68	1.90	27.1
Nickel	19.7	30	200	89.9	320	7.84	16.4	0.431	38.3
Selenium	0.780	1	70	8.48	1.61	1.00	0.87	0.75	2.80
Tin	93.3	50	N/A	19	26	2.90	45	3.77	81
Vanadium	49.7	2	N/A	1,514	503	274	64	30	84
Zinc	75.0	50	200	113	109	0.65	171	5.29	1,174
Organics (µg/kg)									
4,4'-DDT	26	N/A	N/A	3.34	226	1.20	72,072	379	175,708

\* Threshold ESL (if available) for that receptor.

N/A = Not applicable; ESL not available (assessed in Section 10).

**Bold = Receptors of potential concern.**

Table 7.9

Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Large Home Range Receptors  
in the LWNEU Surface Soil

Analyte	Target Home Range Receptor 95th UCL	Receptor-Specific ESLs <sup>a</sup>			
		Mule Deer	Coyote (carnivore)	Coyote (generalist)	Coyote (insectivore)
Inorganics (mg/kg)					
Antimony	9.73	58	138	13	3.85
Nickel	15.1	124	91	6.02	1.86
Tin	48.7	242	70	36	16

<sup>a</sup> Threshold ESL (if available) for that receptor.

**Bold = Receptors of potential concern.**

Table 7.10  
Summary of ECOPC Screening Steps for Surface Soil Non-PMJM Receptors in the LWNEU

Analyte	Exceeds Any NOAEL/ESL?	Detection Frequency >5%?	Exceeds Background?	Upper Bound EPC > Limiting ESL	Professional Judgment: Retain?	ECOPC?	Receptor(s) of Potential Concern
<b>Inorganics</b>							
Aluminum	Yes	Yes	Yes	Yes	No	No	--
Antimony	Yes	Yes	N/A	Yes	No	No	--
Arsenic	Yes	Yes	No	--	--	No	--
Barium	Yes	Yes	Yes	No	--	No	--
Beryllium	No	--	--	--	--	No	--
Boron	Yes	Yes	N/A	Yes	No	No	--
Cadmium	Yes	Yes	No	--	--	No	--
Calcium	UT	--	--	--	--	No	--
Chromium	Yes	Yes	Yes	Yes	No	No	--
Cobalt	No	--	--	--	--	No	--
Copper	Yes	Yes	No	--	--	No	--
Iron	UT	--	--	--	--	No	--
Lead	Yes	Yes	No	--	--	No	--
Lithium	Yes	Yes	Yes	Yes	No	No	--
Magnesium	UT	--	--	--	--	No	--
Manganese	Yes	Yes	No	--	--	No	--
Mercury	Yes	Yes	No	--	--	No	--
Molybdenum	Yes	Yes	N/A	Yes	No	No	--
Nickel	Yes	Yes	Yes	Yes	No	No	--
Nitrate / Nitrite	No	--	--	--	--	No	--
Potassium	UT	--	--	--	--	No	--
Selenium	Yes	Yes	N/A	Yes	No	No	--
Silica	UT	--	--	--	--	No	--
Silicon	UT	--	--	--	--	No	--
Silver	No	--	--	--	--	No	--
Sodium	UT	--	--	--	--	No	--
Strontium	No	--	--	--	--	No	--
Thallium	No	--	--	--	--	No	--
Tin	Yes	Yes	N/A	Yes	No	No	--
Titanium	UT	--	--	--	--	No	--
Vanadium	Yes	Yes	Yes	Yes	No	No	--
Zinc	Yes	Yes	Yes	Yes	No	No	--
<b>Organics</b>							
1,4-Dichlorobenzene	No	--	--	--	--	No	--
4,4'-DDT	Yes	Yes	N/A	Yes	Yes	Yes	American kestrel Mourning dove (insectivore)
Benzoic Acid	UT	--	--	--	--	No	--
bis(2-ethylhexyl)phthalate	No	--	--	--	--	No	--
delta-BHC	No	--	--	--	--	No	--
Methylene Chloride	No	--	--	--	--	No	--
Tetrachloroethene	No	--	--	--	--	No	--
<b>Radionuclides</b>							
Americium-241	No	--	--	--	--	No	--

Table 7.10  
Summary of ECOPC Screening Steps for Surface Soil Non-PMJM Receptors in the LWNEU

Analyte	Exceeds Any NOAEL/ESL?	Detection Frequency >5%?	Exceeds Background?	Upper Bound EPC > Limiting ESL	Professional Judgment - Retain?	ECOPC	Receptor(s) of Potential Concern
Cesium-134	UT	--	--	--	--	No	--
Cesium-137	No	--	--	--	--	No	--
Gross Alpha	UT	--	--	--	--	No	--
Gross Beta	UT	--	--	--	--	No	--
Plutonium-239/240	No	--	--	--	--	No	--
Radium-226	No	--	--	--	--	No	--
Strontium-89/90	No	--	--	--	--	No	--
Uranium-233/234	No	--	--	--	--	No	--
Uranium-235	No	--	--	--	--	No	--
Uranium-238	No	--	--	--	--	No	--

\* Based on results of statistical analysis at the 0.1 level of significance.

-- = Screen not performed because analyte was eliminated from further consideration in a previous ECOPC selection step.

N/A = Not applicable; background comparison could not be conducted.

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

**Bold = Analyte retained as an ECOPC for risk characterization.**

**Table 7.11**  
**Summary of ECOPC Screening Steps for Surface Soil PMJM Receptors in the LWNEU**

Analyte	Exceed PMJM NOAEL ESL?	Exceeds Background <sup>a</sup>	Professional Judgment - Retain?	ECOPC?
<b>Inorganics</b>				
Aluminum	UT	--	--	No
Arsenic	Yes	No	--	No
Barium	No	--	--	No
Beryllium	No	--	--	No
Boron	No	--	--	No
Cadmium	No	--	--	No
Calcium	UT	--	--	No
Chromium	Yes	Yes	No	No
Cobalt	No	--	--	No
Copper	No	--	--	No
Iron	UT	--	--	No
Lead	No	--	--	No
Lithium	No	--	--	No
Magnesium	UT	--	--	No
Manganese	Yes	--	--	No
Mercury	No	--	--	No
Molybdenum	No	--	--	No
Nickel	Yes	Yes	No	No
Nitrate / Nitrite	No	--	--	No
Potassium	UT	--	--	No
Silica	UT	--	--	No
Silver	UT	--	--	No
Sodium	UT	--	--	No
Strontium	No	--	--	No
Thallium	No	--	--	No
Tin	No	--	--	No
Titanium	UT	--	--	No
Vanadium	Yes	No	--	No
Zinc	Yes	No	--	No
<b>Organics</b>				
1,4-Dichlorobenzene	No	--	--	No
Methylene Chloride	No	--	--	No
Tetrachloroethene	No	--	--	No
<b>Radionuclides</b>				
Americium-241	No	--	--	No
Cesium-137	No	--	--	No
Gross Alpha	UT	--	--	No
Gross Beta	UT	--	--	No
Plutonium-239/240	No	--	--	No
Radium-226	No	--	--	No
Strontium-89/90	No	--	--	No
Uranium-233/234	No	--	--	No
Uranium-235	No	--	--	No
Uranium-238	No	--	--	No

<sup>a</sup> Based on results of statistical analysis at the 0.1 level of significance.

-- = Screen not preformed because analyte was eliminated from further consideration in a previous ECOPC selection step.

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

52

**Table 7.12**  
**Comparison of MDCs in Subsurface Soil to NOAEL ESLs for Burrowing**  
**Receptors in the LWNEU**

Analyte	MDC	Prairie Dog NOAEL ESL	MDC > ESL?
<b>Inorganics (mg/kg)</b>			
Aluminum	17,000	N/A	UT
Arsenic	12.8	9.35	Yes
Barium	130	3,220	No
Beryllium	1.30	211	No
Boron	5.33	237	No
Calcium	11,400	N/A	UT
Cesium	1.67	N/A	UT
Chromium <sup>a</sup>	18.0	703	No
Cobalt	21.1	2,460	No
Copper	17.3	838	No
Iron	26,900	N/A	UT
Lead	24.2	1,850	No
Lithium	14.6	3,180	No
Magnesium	4,860	N/A	UT
Manganese	706	1519	No
Mercury	0.089	3.15	No
Molybdenum	7.70	27.1	No
Nickel	24.7	38.3	No
Potassium	2,090	N/A	UT
Selenium	0.720	2.80	No
Silica	751	N/A	UT
Silicon	65.0	N/A	UT
Silver	1.50	N/A	UT
Sodium	1,060	N/A	UT
Strontium	74.7	3,520	No
Thallium	0.340	204	No
Tin	0.736	80.6	No
Titanium	113	N/A	UT
Uranium	10.5	1,230	No
Vanadium	36.4	83.5	No
Zinc	55.9	1,170	No
<b>Organics (µg/kg)</b>			
1,4-Dichlorobenzene	0.620	5.93E+06	No
Acetone	16.0	248,000	No
Methylene Chloride	6.00	210,000	No
Toluene	120	1.22E+06	No
<b>Radionuclides (pCi/g)</b>			
Americium-241	0.850	3,890	No
Cesium-134	0.200	N/A	UT
Cesium-137	0.200	20.8	No
Gross Alpha	30.3	N/A	UT
Gross Beta	29.6	N/A	UT
Plutonium-239/240	2.30	6,110	No
Radium-226	1.20	50.6	No
Radium-228	1.30	43.9	No
Strontium-89/90	0.470	22.5	No
Uranium-233/234	1.30	4,980	No
Uranium-235	0.110	2,770	No
Uranium-238	1.25	1,580	No

<sup>a</sup> The ESLs for chromium were developed based on available toxicity data and are based on chromium (III) (birds) and chromium (VI) (plants, invertebrates, and mammals).  
N/A = Indicates no ESL was available for that ECOL/receptor pair.

53

**Table 7.12**  
**Comparison of MDCs in Subsurface Soil to NOAEL ESLs for Burrowing**  
**Receptors in the LWNEU**

Analyte	MDC	Prairie Dog NOAEL/ESL	MDC > ESL?
---------	-----	--------------------------	------------

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

**Bold = Analyte retained for further consideration in the next ECOPC selection step**

**Table 7.13**  
**Statistical Distributions and Comparison to Background for Subsurface Soil in the LWNEU**

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			LWNEU Data Set			Test	1 - p	Retain as ECOI?
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Arsenic	45	NONPARAMETRIC	93.3	14	NONPARAMETRIC	100	WRS	0.094	Yes

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

WRS = Wilcoxon Rank Sum.

**Table 7.14**  
**Statistical Concentrations in Subsurface Soil in the LWNEU**

Analyte	Total Samples	UCL Recommended by ProUCL	Distribution Recommended by ProUCL	Mean Detected Concentration	Median Detected Concentration	75 <sup>th</sup> Percentile	95 <sup>th</sup> Percentile	UCL	UTL	MDC
<b>Inorganics (mg/kg)</b>										
Arsenic	14	95% Student's-t UCL	NON-PARAMETRIC	5.89	5.29	5.64	11.3	7.11	12.8	12.8

MDC = Maximum detected concentration or in some cases, maximum proxy result.

UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

UTL = 95% upper confidence limit on the 90<sup>th</sup> percentile value, unless the MDC < UTL, then the MDC is used as the UTL.

57

Table 7.15  
Upper-Bound Exposure Point Concentration Comparison to tESLs in the LWNEU Subsurface Soil

Analyte	Burrowing Receptors		
	EPC (95UTL)	tESL <sup>a</sup>	EPC > ESL?
<b>Inorganics (mg/kg)</b>			
Arsenic	12.8 <sup>b</sup>	9.35	Yes

<sup>a</sup> Threshold ESL (if available) for the prairie dog receptor.

<sup>b</sup> The MDC was used as the EPC because the 95UTL was greater than the MDC.

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

Table 7.16  
Summary of ECOPC Screening Steps for Subsurface Soil in the LWNEU

Analyte	Exceed Any NOAEL/ESL?	Detection Frequency >5%?	Exceeds Background?	Upper Bound EPC > Limiting ESL?	Professional Judgment Retain?	Retain as ECOPC?
<b>Inorganics</b>						
Aluminum	UT	--	--	--	--	No
Arsenic	Yes	Yes	Yes	No	--	No
Barium	No	--	--	--	--	No
Beryllium	No	--	--	--	--	No
Boron	No	--	--	--	--	No
Calcium	UT	--	--	--	--	No
Cesium	UT	--	--	--	--	No
Chromium	No	--	--	--	--	No
Cobalt	No	--	--	--	--	No
Copper	No	--	--	--	--	No
Iron	UT	--	--	--	--	No
Lead	No	--	--	--	--	No
Lithium	No	--	--	--	--	No
Magnesium	UT	--	--	--	--	No
Manganese	No	--	--	--	--	No
Mercury	No	--	--	--	--	No
Molybdenum	No	--	--	--	--	No
Nickel	No	--	--	--	--	No
Potassium	UT	--	--	--	--	No
Selenium	No	--	--	--	--	No
Silica	UT	--	--	--	--	No
Silicon	UT	--	--	--	--	No
Silver	UT	--	--	--	--	No
Sodium	UT	--	--	--	--	No
Strontium	No	--	--	--	--	No
Thallium	No	--	--	--	--	No
Tin	No	--	--	--	--	No
Titanium	UT	--	--	--	--	No
Uranium	No	--	--	--	--	No
Vanadium	No	--	--	--	--	No
Zinc	No	--	--	--	--	No
<b>Organics</b>						
1,4-Dichlorobenzene	No	--	--	--	--	No
Acetone	No	--	--	--	--	No
Methylene Chloride	No	--	--	--	--	No
Toluene	No	--	--	--	--	No
<b>Radionuclides</b>						

Table 7.16  
Summary of ECOPC Screening Steps for Subsurface Soil in the LWNEU

Analyte	Exceed Any NOAEL/ESL?	Detection Frequency >5%?	Exceeds Background? <sup>a</sup>	Upper Bound EPC > Limiting ESL?	Professional Judgment - Retain?	Retain as ECOPC?
Americium-241	No	--	--	--	--	No
Cesium-134	UT	--	--	--	--	No
Cesium-137	No	--	--	--	--	No
Gross Alpha	UT	--	--	--	--	No
Gross Beta	UT	--	--	--	--	No
Plutonium-239/240	No	--	--	--	--	No
Radium-226	No	--	--	--	--	No
Radium-228	No	--	--	--	--	No
Strontium-89/90	No	--	--	--	--	No
Uranium-233/234	No	--	--	--	--	No
Uranium-235	No	--	--	--	--	No
Uranium-238	No	--	--	--	--	No

<sup>a</sup> Based on results of statistical analysis at the 0.1 level of significance.

-- = Screen not performed because analyte was eliminated from further consideration in a previous ECOPC selection step.

UT = Uncertain toxicity; ESL not available (assessed in Section 10).

**Table 8.1**  
**Summary of ECOPC/Receptor Pairs**

ECOPC	Receptors of Potential Concern
<b>Surface Soil</b>	
4,4'-DDT	American Kestrel Mourning Dove (insectivore)
<b>Surface Soil - PM10</b>	
None	None
<b>Subsurface Soil</b>	
None	None

60

**Table 8.2**  
**Surface Soil Exposure Point Concentrations for Non-PMJM Receptors**

ECOPC	Tier I Exposure Point Concentrations (mg/kg)		Tier II Exposure Point Concentrations (mg/kg)	
	95th UTL	95th UCL	95th UTL	95th UCL
Organics (µg/kg)				
4,4'-DDT	26	23.5	19.2	14.9

Table 8.3

Surface Water Exposure Point Concentrations for Non-PMJM Receptors

ECOPC	UTL	UCL
Organics (µg/L)		
4,4'-DDT	N/A	N/A

N/A = Data were not available. 4,4'-DDT was not detected in surface water.

Table 8.4  
Receptor-Specific Exposure Parameters

Receptor	Body Weight (kg)	Body Weight Reference	Percentage of Diet				Food Ingestion Rate (kg/kg BW day <sup>-1</sup> )	Ingestion Rate Reference	Water Ingestion Rate (L/kg BW day <sup>-1</sup> )	Ingestion Rate Reference	Percentage of Diet as Soil	Soil Ingestion Reference
			Plant Tissue	Invertebrate Tissue	Bird or Mammal Tissue	Dietary Reference						
Vertebrate Receptors												
American Kestrel	0.116	Brown and Amadon (1968) - Average value	0	20	80	Generalized Diet from several studies presented in the Watershed ERA (DOE 1996)	0.092	Koplin et al. (1980)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	5	Assumed value based on conservative estimates for carnivores
Mourning Dove - Insectivore	0.113	Average of adult values from CalEPA (2004) Online Database	0	100	0	Generalized Diet	0.23	EPA (2003)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	9.3	Beyer et al (1994) - Wild turkey used as a surrogate.

Receptor parameters for all receptors with the exception of the Prairie Dog and the Mourning Dove were taken from the Watershed Risk Assessment (DOE 1996) and referenced to the original source.

All receptor parameters are estimates of central tendency except where noted.

All values are presented in a dry weight basis.

64

Table 8.5  
Receptor-Specific Intake Estimates

Intake Estimates (mg/kg BW day)						
	Plant Tissue	Invertebrate Tissue	Mammal Tissue	Soil	Surface Water <sup>2</sup>	Total
Default Exposure Estimates						
4,4'-DDT						
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	1.94E-01	N/A	5.56E-04	N/A	1.94E-01
Tier 2 UTL	N/A	1.43E-01	N/A	4.11E-04	N/A	1.43E-01
American Kestrel						
Tier 1 UTL	N/A	1.55E-02	5.44E-02	1.20E-04	N/A	7.01E-02
Tier 2 UTL	N/A	1.14E-02	4.02E-02	8.83E-05	N/A	5.17E-02

N/A = Not applicable.

65

**Table 9.1**  
**TRVs for Terrestrial Vertebrate Receptors**

Analyte	NOAEL (mg/kg day)	NOAEL Endpoint	Lowest Bounded LOAEL (mg/kg day)	LOAEL Endpoint	TRV Source	Uncertainty Factor	Final NOAEL (mg/kg day)	TRV Confidence
<b>Birds</b>								
4,4-DDT	0.009	NOAEL was estimated from LOAEL	1.5	Increase in reproductive effects in mallards	PRC (1994)	1	0.009	High

Threshold TRVs were independently calculated using the procedures outline in the CRA Methodology, Section 3.1.4.

**TRV Confidence:**

NA = No TRV has been identified or the TRV has been deemed unacceptable for use in ECOPC selection.

Low = TRVs that have data for only one species looking at one endpoint (non-mortality) and from one primary literature source.

Moderate = TRVs that have multiple primary literature sources looking at one endpoint (non-mortality or mortality) but with only one species evaluated.

Good = For TRVs that have either multiple species with one endpoint from multiple studies or those TRVs with multiple species and multiple endpoints from only one study.

High = For TRVs that have multiple study sources looking at multiple endpoints and more than one species.

Very High = All EcoSSLs (EPA 2003a) will be assigned this level of confidence by default.

**Table 10.1**  
**Hazard Quotient Summary for Non-PMJM Receptors**

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Alternate TRVs (Uncertainty Analysis)
4,4'-DDT	Mourning Dove (Insectivore)	Default	Tier 1	NOAEL UTL = 22 LOAEL UTL = 0.1	Not Calculated
			Tier 2	NOAEL UTL = 16 LOAEL UTL = 0.1	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	American kestrel	Default	Tier 1	NOAEL UTL = 8 LOAEL UTL = 0.05	Not Calculated
			Tier 2	NOAEL UTL = 6 LOAEL UTL = 0.03	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

Shaded cells represent default HQ calculations based on exposure and toxicity models specifically identified in the CRA Methodology.

All HQ Calculations are provided in Attachment 4.

Discussion of the chemical-specific uncertainties are provided in Attachment 5.

66

6

Table 10.2  
Tier 2 Grid Cell Hazard Quotients for Surface Soil in LWNEU

ECOPC	Most Sensitive Receptor	Number of Grid Cells	Percent of Tier 2 Grid Means											
			NOAEL TRV				Threshold TRV				LOAEL TRV			
			HQ < 1	HQ > 1 < 5	HQ > 5 < 10	HQ > 10	HQ < 1	HQ > 1 < 5	HQ > 5 < 10	HQ > 10	HQ < 1	HQ > 1 < 5	HQ > 5 < 10	HQ > 10
4,4'-DDT	Mourning Dove - Insectivore	8	0	0	0	100	N/A	N/A	N/A	N/A	100	0	0	0

N/A = No value available.

The limiting receptor is chosen as the receptor with the lowest ESL.

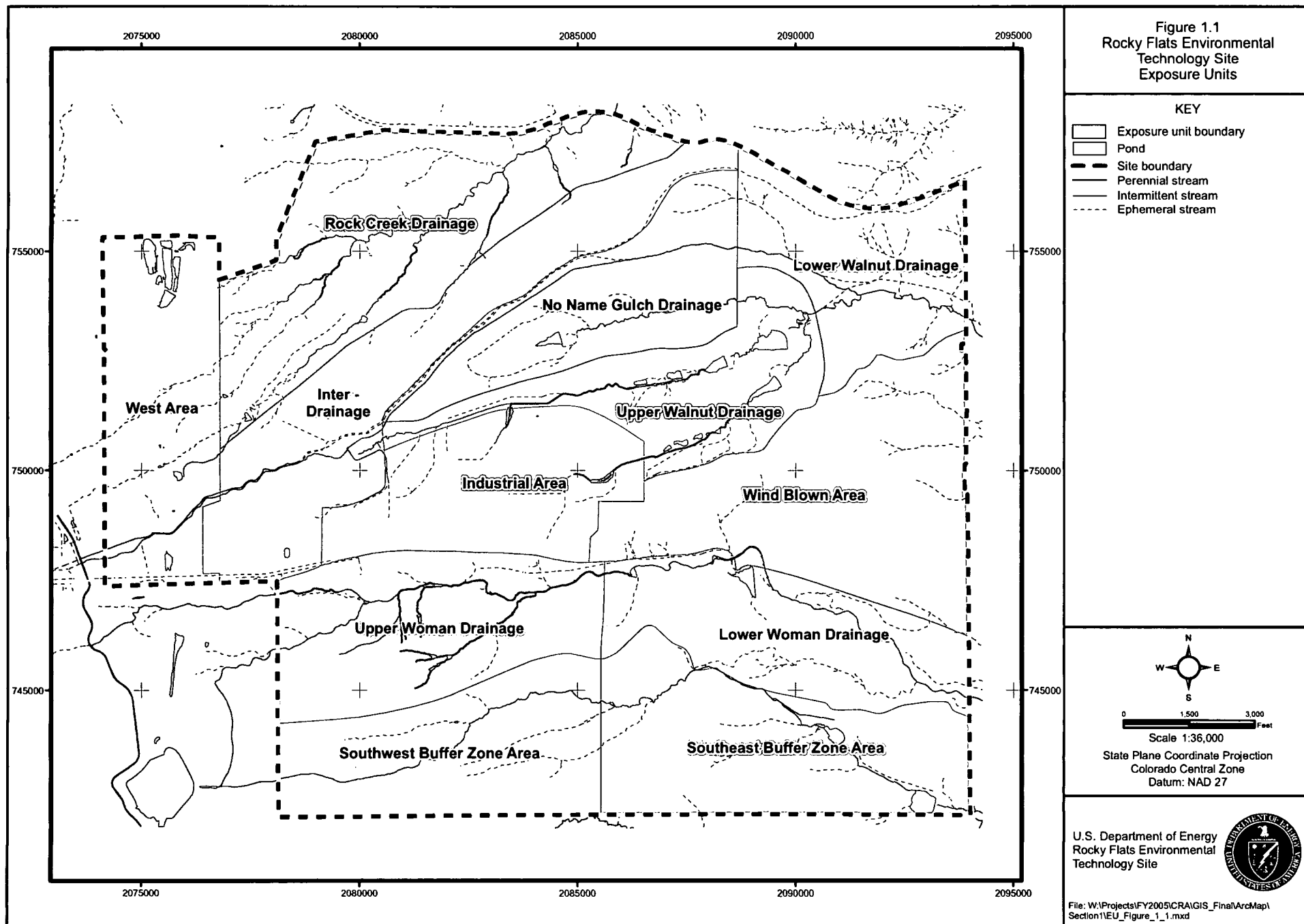
Default exposure and toxicity parameters used.

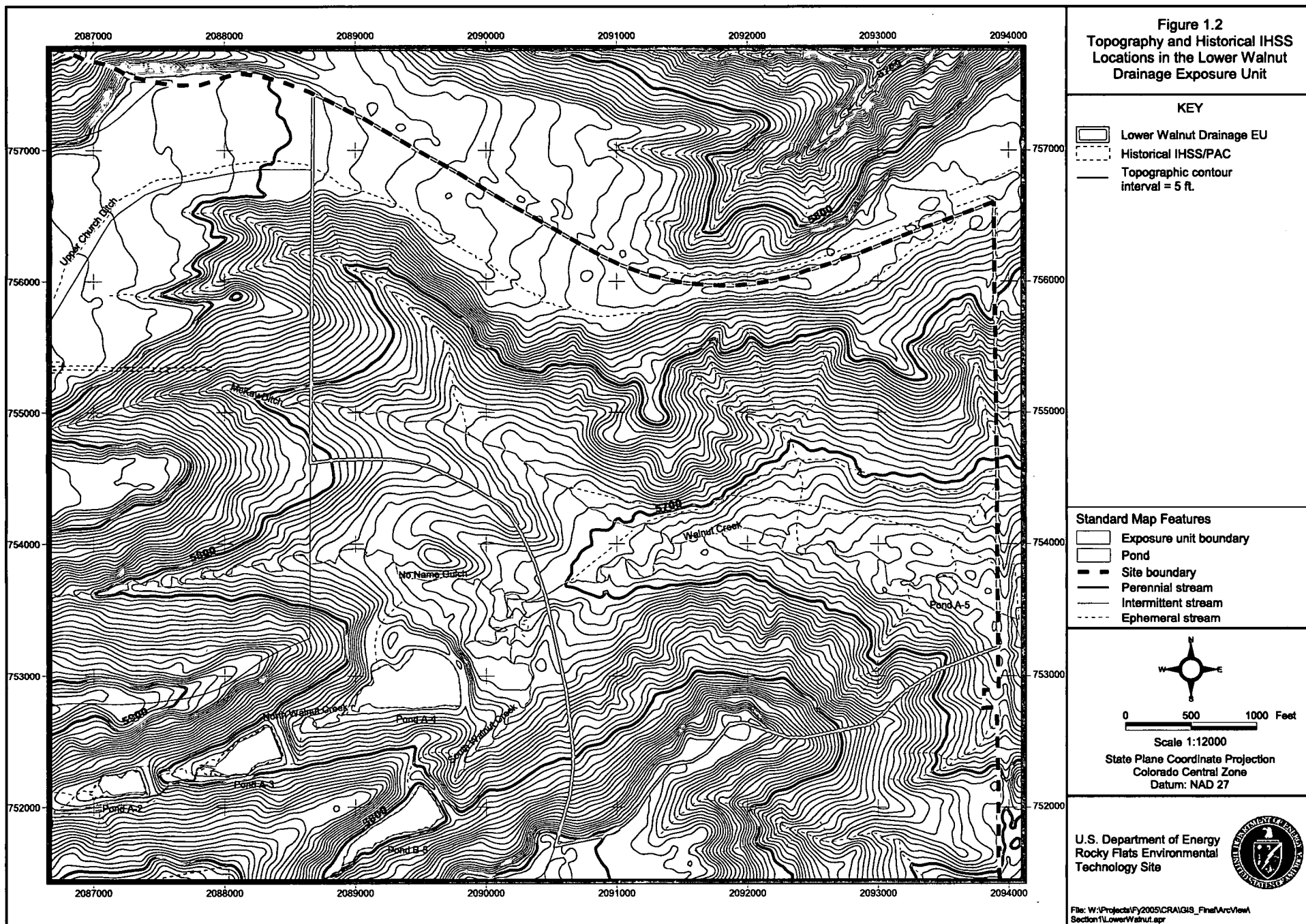
**Table 11.1**  
**Summary of Risk Characterization Results for the LWNEU**

Analyte	Ecological Receptors	Result of Risk Characterization	Lines of Evidence Risk Conclusions
<b>Surface Soil Non-PMJM Receptors</b>			
4,4'-DDT	Terrestrial Plants	Not an ECOPC	ECOPC of Uncertain Risk
	Terrestrial Invertebrate	Not an ECOPC	ECOPC of Uncertain Risk
	American Kestrel	NOAEL HQs >1 for default scenarios LOAEL HQs <1 for default scenarios	Low Risk
	Mourning Dove (herbivore)	Not an ECOPC	Not an ECOPC
	Mourning Dove (Insectivore)	NOAEL HQs >1 for default scenarios LOAEL HQs <1 for default scenarios	Low Risk
	Deer Mouse (herbivore)	Not an ECOPC	Not an ECOPC
	Deer Mouse (Insectivore)	Not an ECOPC	Not an ECOPC
	Prairie Dog	Not an ECOPC	Not an ECOPC
	Coyote (carnivore)	Not an ECOPC	Not an ECOPC
	Coyote (generalist)	Not an ECOPC	Not an ECOPC
	Coyote (insectivore)	Not an ECOPC	Not an ECOPC
	Mule Deer	Not an ECOPC	Not an ECOPC
<b>Surface Soil PMJM Receptors</b>			
None	Preble's Meadow Jumping Mouse	No ECOPCs	No ECOPCs
<b>Subsurface Soil</b>			
None	Prairie Dog	No ECOPCs	No ECOPCs

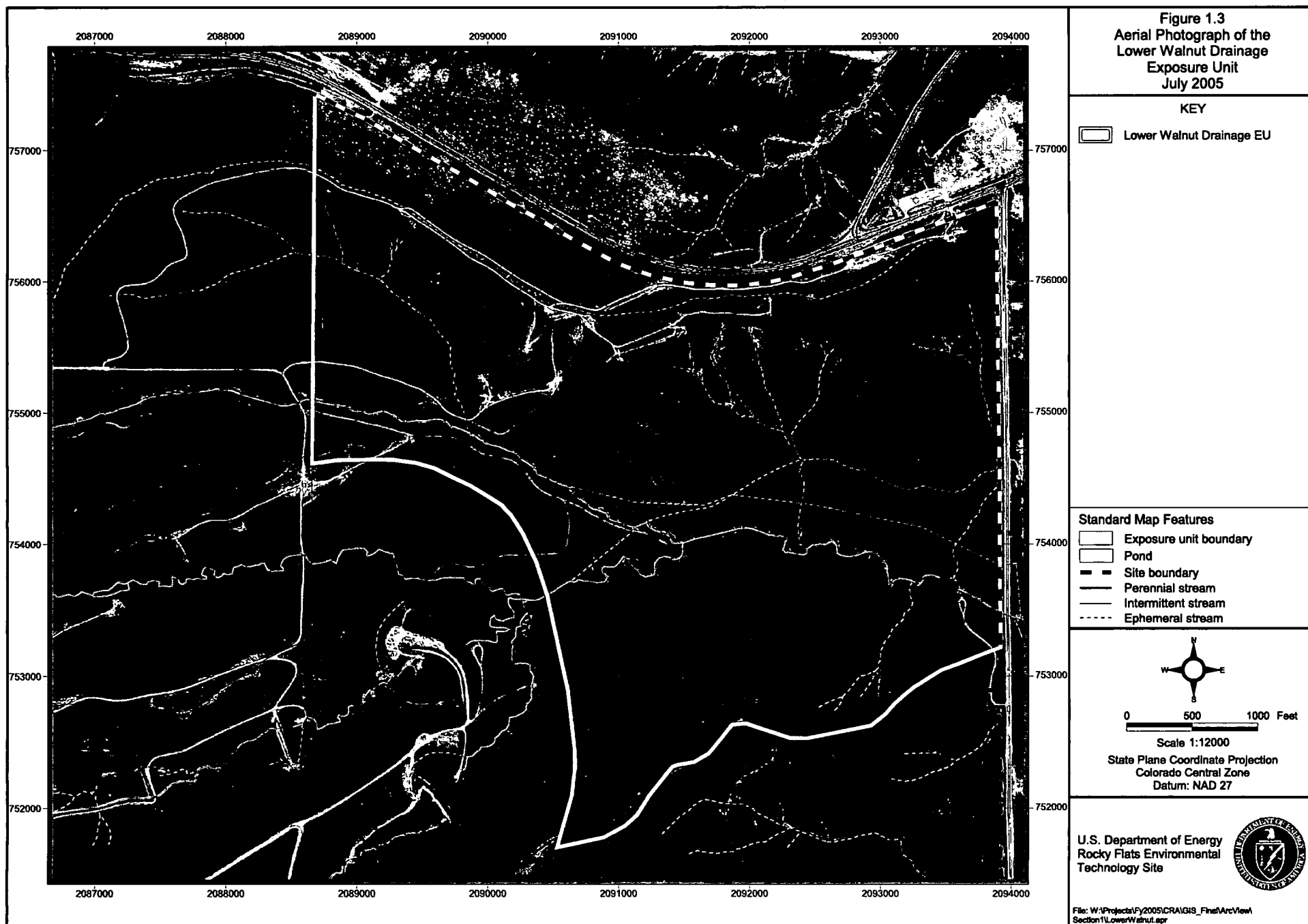
<sup>a</sup> Risk conclusions discussed in detail for each ECOPC in Section 10.

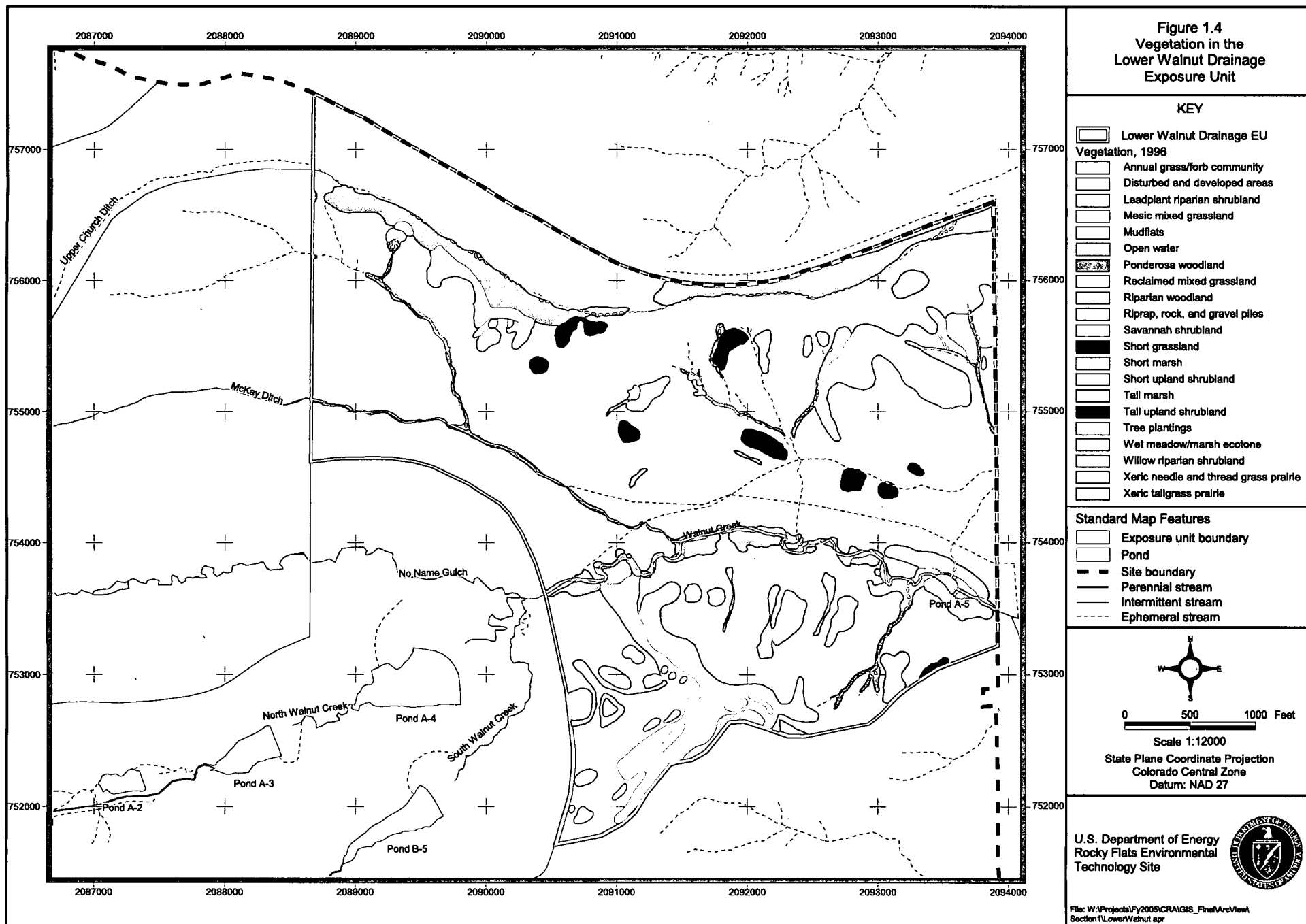
## FIGURES

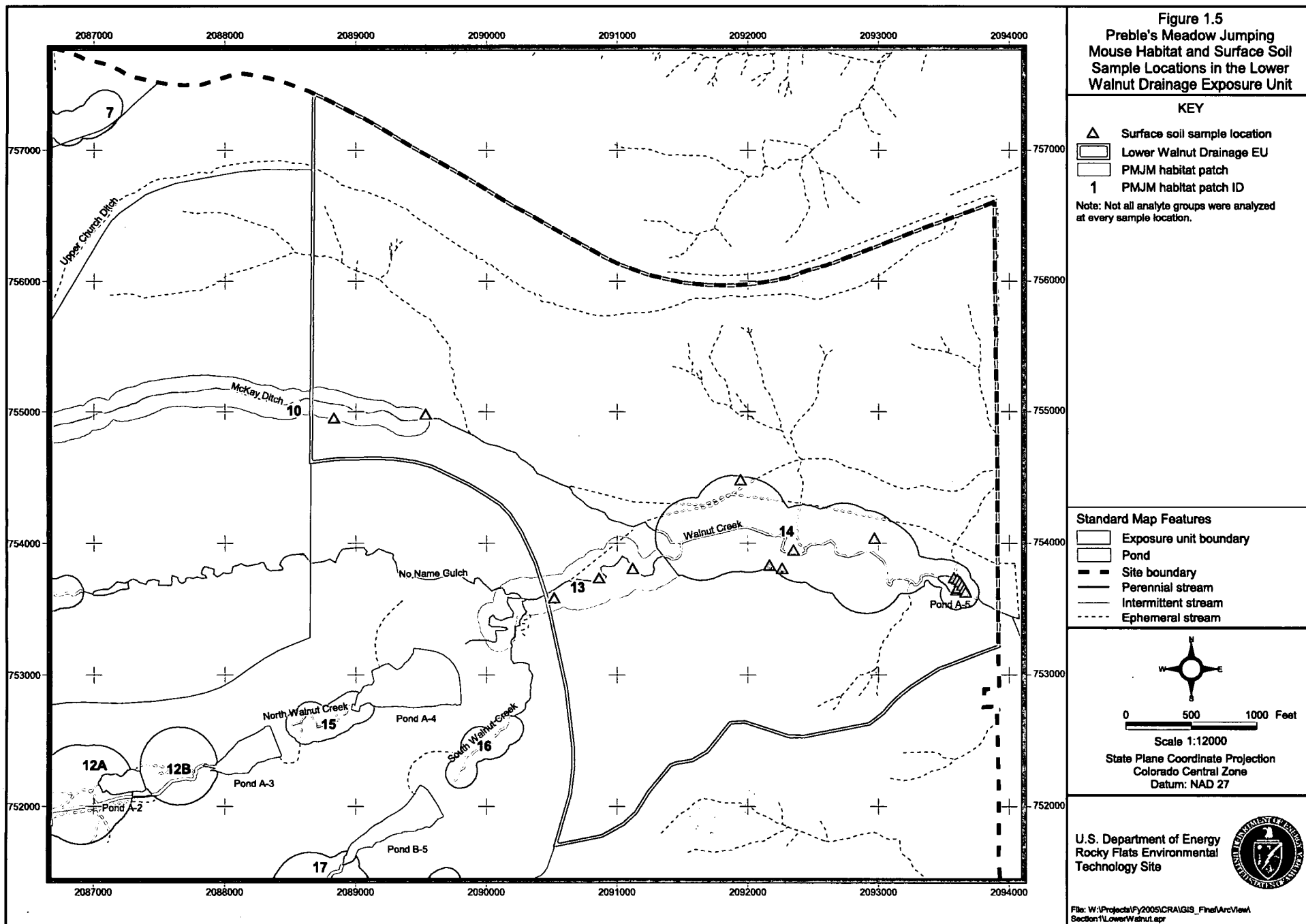


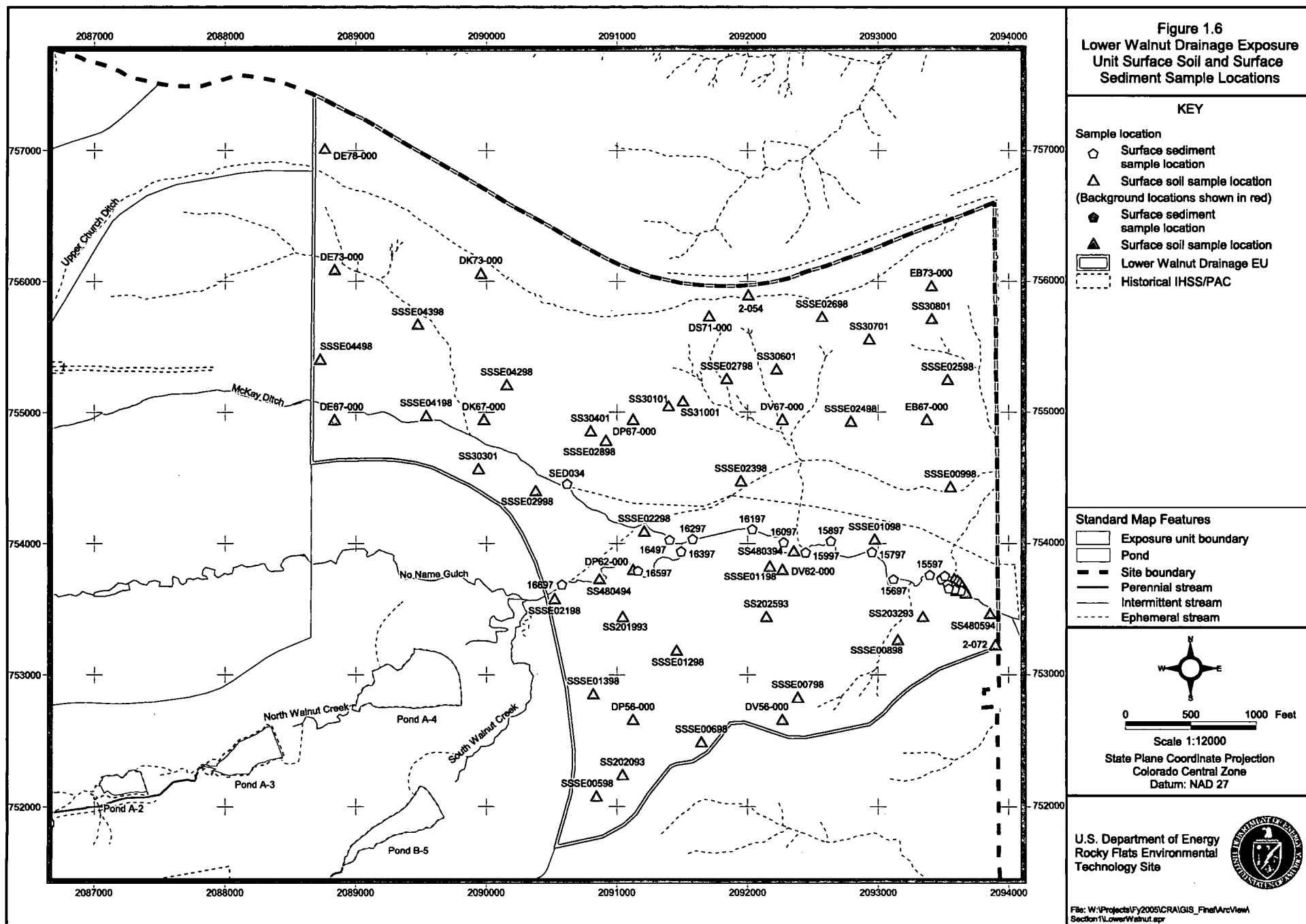


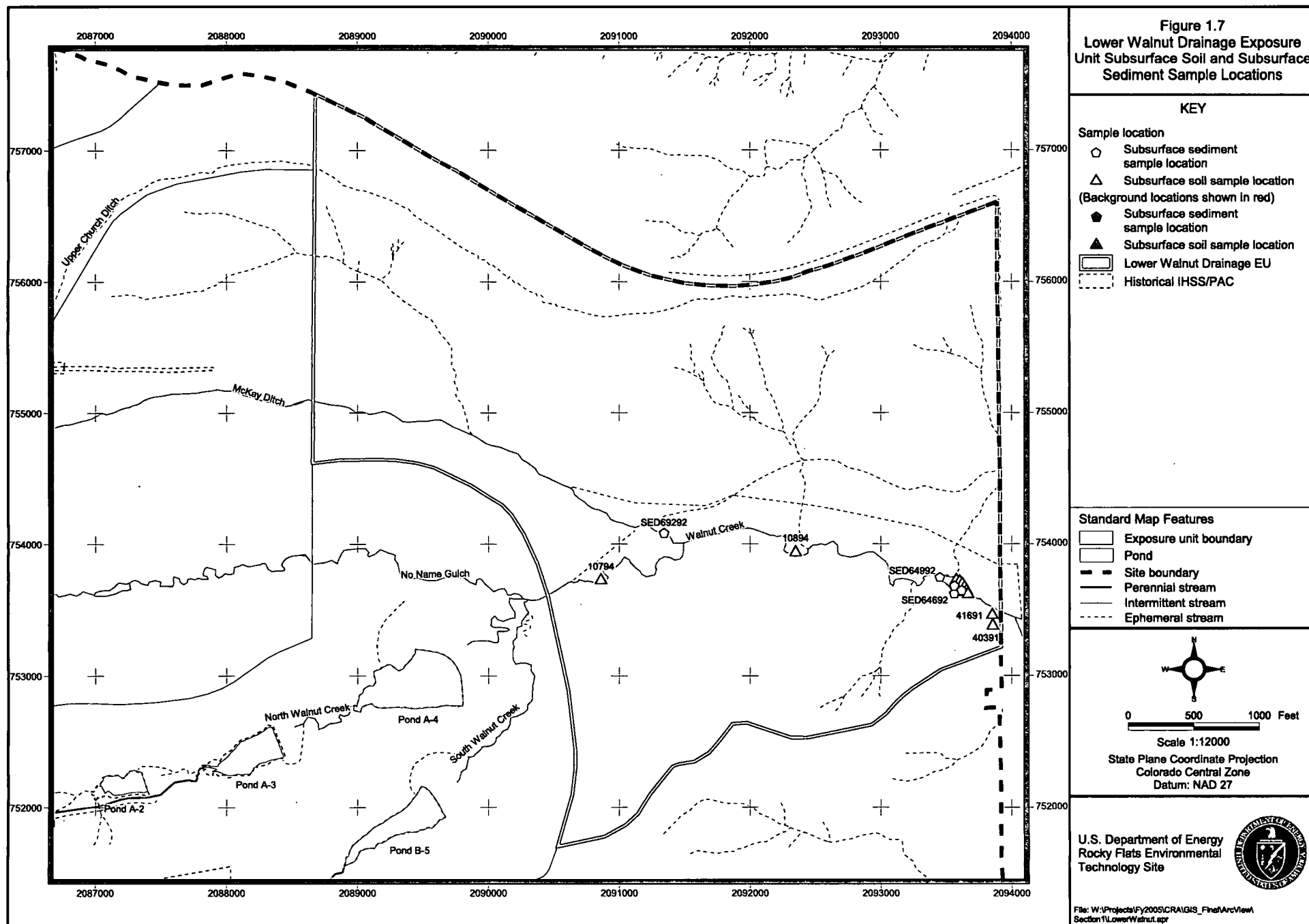
22

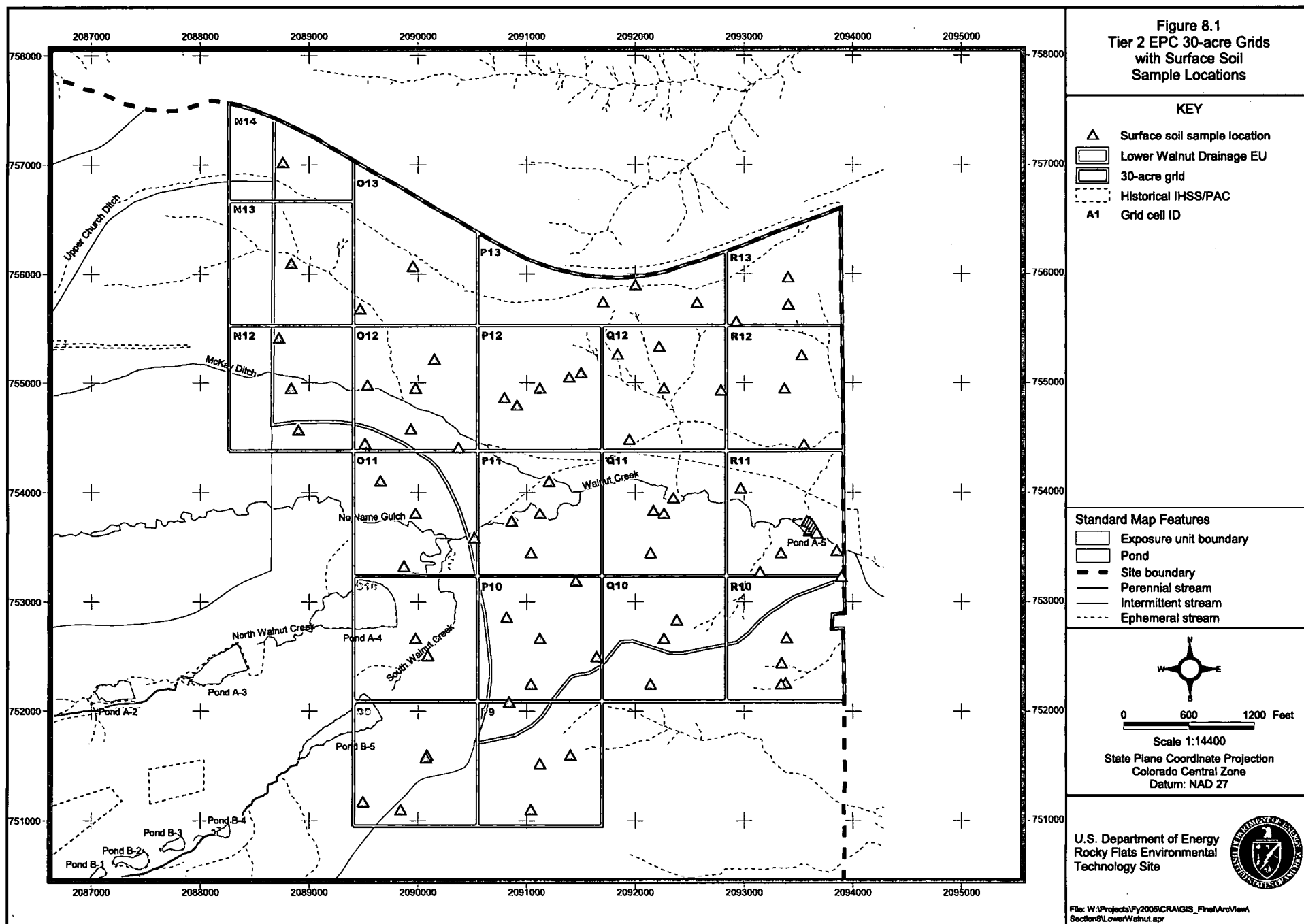




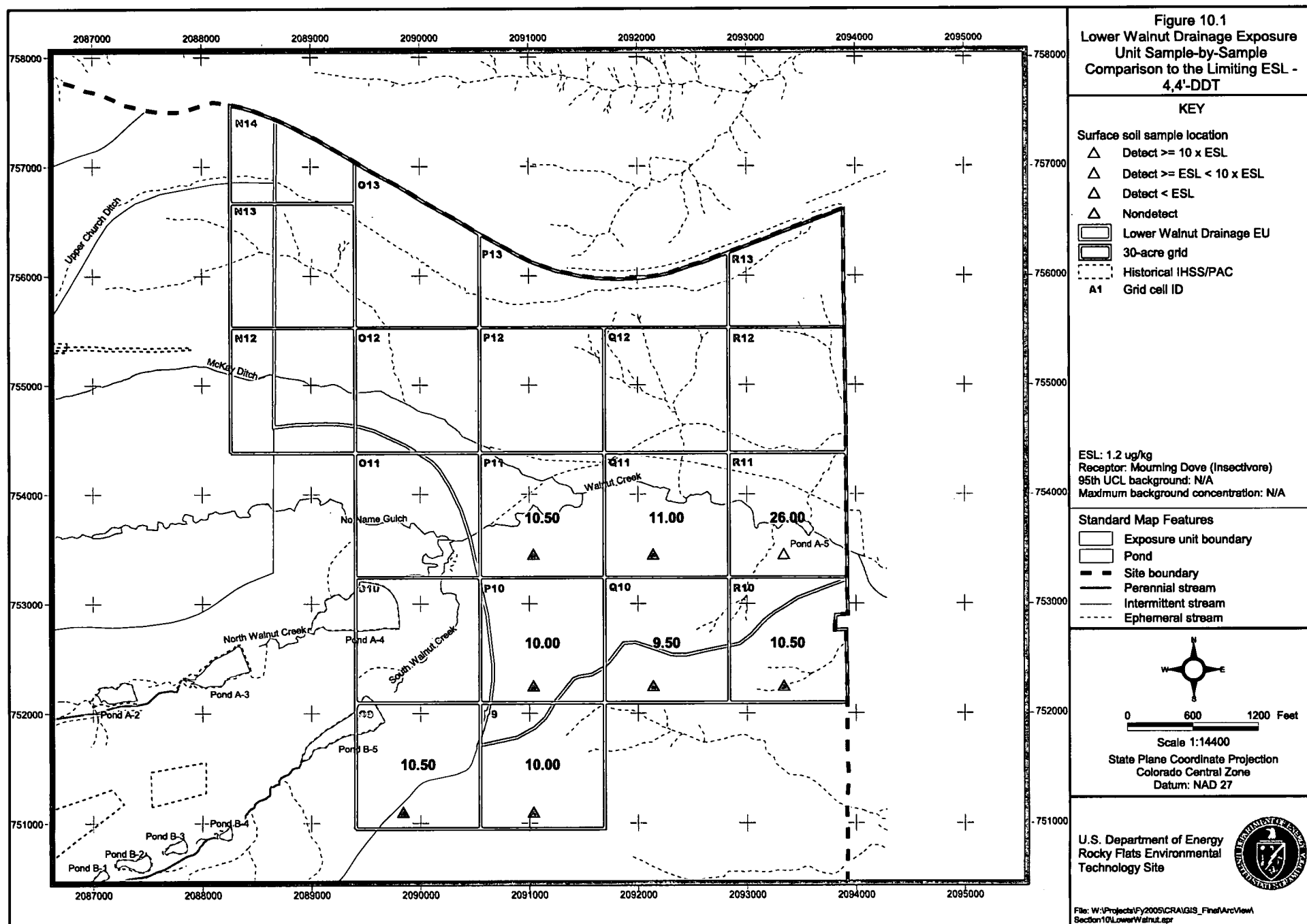








78



**COMPREHENSIVE RISK ASSESSMENT**

**LOWER WALNUT DRAINAGE EXPOSURE UNIT**

**VOLUME 8: ATTACHMENT 1**

**Detection Limit Screen**

## TABLE OF CONTENTS

<b>ACRONYMS AND ABBREVIATIONS.....</b>	<b>iii</b>
<b>1.0 EVALUATION OF DETECTION LIMITS FOR NONDETECTED ANALYTES IN THE LOWER WALNUT DRAINAGE EXPOSURE UNIT</b>	<b>1</b>
1.1 Comparison of Maximum Reported Results to Preliminary Remediation Goals .....	1
1.1.1 Surface Soil/Surface Sediment .....	1
1.1.2 Subsurface Soil/Subsurface Sediment .....	1
1.2 Comparison of Maximum Reported Results to Ecological Screening Levels.....	2
1.2.1 Surface Soil.....	2
1.2.2 Subsurface Soil .....	2

## LIST OF TABLES

Table A1.1	Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment
Table A1.2	Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil/Subsurface Sediment
Table A1.3	Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil
Table A1.4	Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil

## ACRONYMS AND ABBREVIATIONS

µg/kg	micrograms per kilogram
CD	compact disc
CRA	comprehensive risk assessment
ERA	Ecological Risk Assessment
ESL	ecological screening level
LWNEU	Lower Walnut Exposure Unit
MaxDL	maximum detection limit
NOAEL	no observed adverse effect level
PCB	polychlorinated biphenyl
PRG	preliminary remediation goal
RFETS	Rocky Flats Environmental Technology Site
TIC	Tentatively Identified Compound
VOC	volatile organic compound
WRW	wildlife refuge worker

## **1.0 EVALUATION OF DETECTION LIMITS FOR NONDETECTED ANALYTES IN THE LOWER WALNUT DRAINAGE EXPOSURE UNIT**

The detection limits for analytes not detected in, or detected in less than 5 percent of, the samples collected in the media used in the Human Health Risk Assessment (HHRA) or the Ecological Risk Assessment (ERA) are compared to human health preliminary remediation goals (PRGs) for the wildlife refuge worker (WRW) and ecological screening levels (ESLs) for a variety of ecological receptors. The comparisons are made in Tables A1.1 through A1.4 for potential contaminants of concern (PCOCs) in surface soil/surface sediment and subsurface soil/subsurface sediment, and ecological contaminants of interest (ECOIs) in surface soil and subsurface soil. The reported detection limits (referred to as “reported results” in the following sections of this attachment) are listed in these tables for each medium in the Lower Walnut Drainage Exposure Unit (LWNEU). When reported results exceed the respective PRGs and ESLs, this is a source of uncertainty in the risk assessment process, and these occurrences are noted and discussed. The reported results are the lowest levels at which the analyte could be accurately and reproducibly quantified, taking into account the sample characteristics, sample collection, sample preparation, and analytical adjustments. The term analyte as used in the following sections refers to analytes that are nondetected or detected in less than 5 percent of the samples.

### **1.1 Comparison of Maximum Reported Results to Preliminary Remediation Goals**

#### **1.1.1 Surface Soil/Surface Sediment**

The maximum reported results for three analytes in surface soil/surface sediment, benzo(a)pyrene, dibenz(a,h)anthracene, and n-nitroso-di-n-propylamine are greater than the PRG (Table A1.1). The minimum reported results for these analytes are below the PRG. Since the exceedances of the maximum reported results over the PRG are small, and those for the majority of the analytes were much lower than the PRG, uncertainties associated with reported results greater than the PRGs are expected to be small.

PRGs are not available for one inorganic and several organic analytes in surface soil/surface sediment (Table A1.1). Because PRGs are available for most of the organics in surface soil/surface sediment, and the maximum reported results for these analytes are much lower than the PRGs, the lack of PRGs for a few analytes is unlikely to have a significant effect on the results of the risk assessment. In addition, the fact that no identified source exists for these analytes in the LWNEU indicates that the uncertainty associated with the reported results for these analytes is acceptable.

#### **1.1.2 Subsurface Soil/Subsurface Sediment**

No analytes have maximum reported results that exceed the PRG in subsurface soil/subsurface sediment (Table A1.2).

PRGs are not available for several organic analytes in subsurface soil/subsurface sediment (Table A1.2). Because PRGs are available for most of the organics in subsurface soil/subsurface sediment, and the maximum reported results for these analytes

are much lower than the PRGs, the lack of PRGs for only a few organics is unlikely to have a significant effect on the results of the risk assessment. In addition, the fact that no identified source exists for these analytes in the LWNEU indicates that the uncertainty associated with the reported results for these analytes is acceptable.

## **1.2 Comparison of Maximum Reported Results to Ecological Screening Levels**

### **1.2.1 Surface Soil**

The maximum reported results for several analytes in surface soil are greater than the ESL (Table A1.3). However, a large number of analytes in surface soil have maximum reported results that are much less than the ESLs, indicating that the detection limits are adequate for most analytes. In addition, since there is no indication that the analytes with maximum reported results above the ESLs are present at the LWNEU, this is not expected to impact the conclusions of the risk assessment.

ESLs are not available for several organic analytes in surface soil (Table A1.3). Because ESLs are available for most of the organics in surface soil, and the maximum reported results for these analytes are much lower than the ESLs, the lack of ESLs for these organics is unlikely to have a significant effect on the results of the risk assessment. In addition, the fact that no identified source exists for these analytes in the LWNEU indicates that the uncertainty associated with the reported results for these analytes is acceptable.

### **1.2.2 Subsurface Soil**

The minimum and maximum reported results for all analytes in subsurface soil are below their respective ESLs (Table A1.4).

ESLs were not available for several analytes in subsurface soil (Table A1.4). Because the maximum reported results for analytes with ESLs available are generally much lower than the ESLs, suggesting that these analytes are not present at levels near the ESLs, the lack of ESLs for some analytes is not likely to have a significant effect on the results of the risk assessment.

## **TABLES**

**Table A1.1**  
**Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency**  
**Less than 5 Percent in Surface Soil/Surface Sediment<sup>a</sup>**

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG <sup>b</sup>
<b>Inorganics (mg/kg)</b>				
Cesium	0.830 - 140	7	N/A	UT
Chromium (VI)	1.10 - 1.10	1	28.4	No
Uranium	1.60 - 18	17	333	No
<b>Organics (µg/kg)</b>				
1,1,1,2-Tetrachloroethane	5.80 - 6.40	8	91,018	No
1,1,1-Trichloroethane	5 - 10	11	9.18E+06	No
1,1,2,2-Tetrachloroethane	5 - 10	11	10,483	No
1,1,2-Trichloro-1,2,2-trifluoroethane	5.80 - 6.40	8	2.38E+09	No
1,1,2-Trichloroethane	5 - 10	11	28,022	No
1,1-Dichloroethane	5 - 10	11	2.72E+06	No
1,1-Dichloroethene	5 - 10	11	17,366	No
1,1-Dichloropropene	5.80 - 6.40	8	N/A	UT
1,2,3-Trichlorobenzene	5.80 - 6.40	8	N/A	UT
1,2,3-Trichloropropane	5.80 - 6.40	8	2,079	No
1,2,4-Trichlorobenzene	5.80 - 600	15	151,360	No
1,2,4-Trimethylbenzene	5.80 - 6.40	8	132,620	No
1,2-Dibromo-3-chloropropane	5.80 - 6.40	8	2,968	No
1,2-Dibromoethane	5.80 - 6.40	8	35.1	No
1,2-Dichlorobenzene	5.80 - 600	15	2.89E+06	No
1,2-Dichloroethane	5 - 10	11	13,270	No
1,2-Dichloroethene	5 - 10	3	999,783	No
1,2-Dichloropropane	5 - 10	11	38,427	No
1,3,5-Trimethylbenzene	5.80 - 6.40	8	114,340	No
1,3-Dichlorobenzene	5.80 - 600	15	3.33E+06	No
1,3-Dichloropropane	5.80 - 6.40	8	N/A	UT
2,2-Dichloropropane	5.80 - 6.40	8	N/A	UT
2,4,5-Trichlorophenol	1,700 - 2,900	7	8.01E+06	No
2,4,6-Trichlorophenol	340 - 600	7	272,055	No
2,4-Dichlorophenol	340 - 600	7	240,431	No
2,4-Dimethylphenol	340 - 600	7	1.60E+06	No
2,4-Dinitrophenol	1,700 - 2,900	7	160,287	No
2,4-Dinitrotoluene	340 - 600	7	160,287	No
2,6-Dinitrotoluene	340 - 600	7	80,144	No
2-Chloronaphthalene	340 - 600	7	6.41E+06	No
2-Chlorophenol	340 - 600	7	555,435	No
2-Chlorotoluene	5.80 - 6.40	8	2.22E+06	No
2-Hexanone	10 - 64.2	11	N/A	UT
2-Methylnaphthalene	340 - 600	7	320,574	No
2-Methylphenol	340 - 600	7	4.01E+06	No
2-Nitroaniline	1,700 - 2,900	7	192,137	No
2-Nitrophenol	340 - 600	7	N/A	UT
3,3'-Dichlorobenzidine	680 - 1,200	7	6,667	No
3-Nitroaniline	1,700 - 2,900	6	N/A	UT
4,4'-DDD	16 - 29	7	15,528	No
4,4'-DDE	16 - 70	7	10,961	No

Table A1.1

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency  
Less than 5 Percent in Surface Soil/Surface Sediment<sup>a</sup>

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG <sup>b</sup>
4,6-Dinitro-2-methylphenol	1,700 - 2,900	7	8,014	No
4-Bromophenyl-phenylether	340 - 600	7	N/A	UT
4-Chloro-3-methylphenol	340 - 600	7	N/A	UT
4-Chloroaniline	340 - 600	7	320,574	No
4-Chlorophenyl-phenyl ether	340 - 600	7	N/A	UT
4-Chlorotoluene	5.80 - 6.40	8	N/A	UT
4-Isopropyltoluene	5.80 - 6.40	8	N/A	UT
4-Methyl-2-pentanone	10 - 64.2	11	8.32E+07	No
4-Methylphenol	340 - 600	7	400,718	No
4-Nitroaniline	1,700 - 2,900	7	207,917	No
4-Nitrophenol	1,700 - 2,900	7	641,148	No
Acenaphthene	340 - 600	7	4.44E+06	No
Acenaphthylene	340 - 600	7	N/A	UT
Aldrin	8.10 - 14	7	176	No
alpha-BHC	8.10 - 14	7	570	No
alpha-Chlordane	81 - 140	7	10,261	No
Anthracene	340 - 600	7	2.22E+07	No
Aroclor-1016	81 - 140	7	1,349	No
Aroclor-1221	81 - 140	7	1,349	No
Aroclor-1232	81 - 140	7	1,349	No
Aroclor-1242	81 - 140	7	1,349	No
Aroclor-1248	81 - 140	7	1,349	No
Aroclor-1254	160 - 290	7	1,349	No
Aroclor-1260	160 - 290	7	1,349	No
Benzene	5 - 10	11	23,563	No
Benzo(a)anthracene	340 - 600	7	3,793	No
<b>Benzo(a)pyrene</b>	<b>340 - 600</b>	<b>7</b>	<b>379</b>	<b>Yes</b>
Benzo(b)fluoranthene	340 - 600	7	3,793	No
Benzo(g,h,i)perylene	340 - 600	7	N/A	UT
Benzo(k)fluoranthene	340 - 600	7	37,927	No
Benzyl Alcohol	340 - 600	7	2.40E+07	No
beta-BHC	8.10 - 14	7	1,995	No
beta-Chlordane	100 - 140	6	10,261	No
bis(2-Chloroethoxy) methane	340 - 600	7	N/A	UT
bis(2-Chloroethyl) ether	340 - 600	7	3,767	No
bis(2-Chloroisopropyl) ether	340 - 600	7	59,301	No
Bromobenzene	5.80 - 6.40	8	N/A	UT
Bromochloromethane	5.80 - 6.40	8	N/A	UT
Bromodichloromethane	5 - 10	11	67,070	No
Bromoform	5 - 10	11	419,858	No
Bromomethane	5.80 - 21	11	20,959	No
Butylbenzylphthalate	340 - 600	7	1.60E+07	No
Carbon Disulfide	5 - 10	11	1.64E+06	No
Carbon Tetrachloride	5 - 10	11	8,446	No
Chlorobenzene	5 - 10	11	666,523	No
Chloroethane	5.80 - 21	11	1.43E+06	No

**Table A1.1**  
**Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency**  
**Less than 5 Percent in Surface Soil/Surface Sediment<sup>a</sup>**

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG?
Chloroform	5 - 10	11	7,850	No
Chloromethane	5.80 - 21	11	115,077	No
Chrysene	340 - 600	7	379,269	No
cis-1,2-Dichloroethene	5.80 - 6.40	8	1.11E+06	No
cis-1,3-Dichloropropene	5 - 10	11	19,432	No
Dibenz(a,h)anthracene	340 - 600	7	379	Yes
Dibenzofuran	340 - 600	7	222,174	No
Dibromochloromethane	5 - 10	11	49,504	No
Dibromomethane	5.80 - 6.40	8	N/A	UT
Dichlorodifluoromethane	5.80 - 6.40	8	229,820	No
Dieldrin	16 - 29	7	187	No
Diethylphthalate	340 - 600	7	6.41E+07	No
Dimethylphthalate	340 - 600	7	8.01E+08	No
Di-n-octylphthalate	340 - 600	7	3.21E+06	No
Endosulfan I	8.10 - 14	7	480,861	No
Endosulfan II	16 - 29	7	480,861	No
Endosulfan sulfate	16 - 29	7	480,861	No
Endrin	16 - 29	7	24,043	No
Endrin ketone	16 - 29	7	33,326	No
Ethylbenzene	5 - 10	11	5.39E+06	No
Fluoranthene	340 - 600	7	2.96E+06	No
Fluorene	340 - 600	7	3.21E+06	No
gamma-BHC (Lindane)	8.10 - 14	7	2,771	No
gamma-Chlordane	81 - 81	1	10,261	No
Heptachlor	8.10 - 14	7	665	No
Heptachlor epoxide	8.10 - 14	7	329	No
Hexachlorobenzene	340 - 600	7	1,870	No
Hexachlorobutadiene	5.80 - 600	15	22,217	No
Hexachlorocyclopentadiene	340 - 600	7	380,452	No
Hexachloroethane	340 - 600	7	111,087	No
Indeno(1,2,3-cd)pyrene	340 - 600	7	3,793	No
Isophorone	340 - 600	7	3.16E+06	No
Isopropylbenzene	5.80 - 6.40	8	32,680	No
Methoxychlor	81 - 140	7	400,718	No
Naphthalene	5.80 - 600	15	1.40E+06	No
n-Butylbenzene	5.80 - 6.40	8	N/A	UT
Nitrobenzene	340 - 600	7	43,246	No
N-Nitroso-di-n-propylamine	340 - 600	7	429	Yes
N-nitrosodiphenylamine	340 - 600	7	612,250	No
n-Propylbenzene	5.80 - 6.40	8	N/A	UT
Pentachlorophenol	1,700 - 2,900	7	17,633	No
Phenanthrene	340 - 600	7	N/A	UT
Pyrene	340 - 600	7	2.22E+06	No
sec-Butylbenzene	5.80 - 6.40	8	N/A	UT
Styrene	5 - 10	11	1.38E+07	No
tert-Butylbenzene	5.80 - 6.40	8	N/A	UT

85

Table A1.1

**Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency  
Less than 5 Percent in Surface Soil/Surface Sediment<sup>a</sup>**

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG? <sup>b</sup>
Toxaphene	160 - 290	7	2,720	No
trans-1,2-Dichloroethene	5.80 - 6.40	8	287,340	No
trans-1,3-Dichloropropene	5 - 10	11	20,820	No
Trichloroethene	5 - 10	11	1,770	No
Trichlorofluoromethane	5.80 - 6.40	8	1.51E+06	No
Vinyl acetate	10 - 21	3	2.65E+06	No
Vinyl Chloride	5.80 - 21	11	2,169	No
Xylene <sup>c</sup>	5 - 10	11	1.06E+06	No

<sup>a</sup> No analytes were detected in less than 5 percent of samples.

<sup>b</sup> Value is the maximum reported result for nondetected analytes.

<sup>c</sup> The value for total xylene is used.

N/A = Not Available.

UT = Uncertain toxicity.

Table A1.2

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency  
Less than 5 Percent in Subsurface Soil/Subsurface Sediment<sup>a</sup>

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG?
<b>Inorganics (mg/kg)</b>				
Antimony	0.510 - 20	18	511	No
Cadmium	0.0380 - 1.50	20	1,051	No
<b>Organics (µg/kg)</b>				
4-Methyl-2-pentanone	11 - 62.1	19	9.57E+08	No
Benzene	5 - 9	21	270,977	No
Bromobenzene	5.50 - 6.20	8	N/A	UT
Bromochloromethane	5.50 - 6.20	8	N/A	UT
Bromodichloromethane	5 - 9	21	771,304	No
Bromoform	5 - 9	21	4.83E+06	No
Bromomethane	5.50 - 18	20	241,033	No
Carbon Disulfide	5 - 9	21	1.88E+07	No
Carbon Tetrachloride	5 - 9	21	97,124	No
Chlorobenzene	5 - 9	21	7.67E+06	No
Chloroethane	5.50 - 18	20	1.65E+07	No
Chloroform	5 - 9	21	90,270	No
Chloromethane	5.50 - 18	21	1.32E+06	No
cis-1,2-Dichloroethene	5.50 - 6.20	8	1.28E+07	No
cis-1,3-Dichloropropene	5 - 9	21	223,462	No
Dibromochloromethane	5 - 9	21	569,296	No
Dibromomethane	5.50 - 6.20	8	N/A	UT
Dichlorodifluoromethane	5.50 - 6.20	8	2.64E+06	No
Ethylbenzene	5 - 9	21	6.19E+07	No
4-Nitrophenol	2,000 - 2,600	5	7.37E+06	No
4,4'-DDD	20 - 26	5	178,570	No
4,4'-DDE	20 - 26	5	126,049	No
4,4'-DDT	20 - 26	5	125,658	No
Aldrin	9.80 - 13	5	2,024	No
alpha-BHC	9.80 - 13	5	6,555	No
alpha-Chlordane	98 - 130	5	117,997	No
Aroclor-1016	98 - 130	5	15,514	No
Aroclor-1221	98 - 130	5	15,514	No
Aroclor-1232	98 - 130	5	15,514	No
Aroclor-1242	98 - 130	5	15,514	No
Aroclor-1248	98 - 130	5	15,514	No
Aroclor-1254	200 - 260	5	15,514	No
Aroclor-1260	200 - 260	5	15,514	No
beta-BHC	9.80 - 13	5	22,942	No
beta-Chlordane	98 - 130	5	117,997	No
delta-BHC	9.80 - 13	5	6,555	No
Dieldrin	20 - 26	5	2,151	No
Endosulfan I	9.80 - 13	5	5.53E+06	No
Endosulfan II	20 - 26	5	5.53E+06	No
Endosulfan sulfate	20 - 26	5	5.53E+06	No
Endrin	20 - 26	5	276,495	No

Table A1.2

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency  
Less than 5 Percent in Subsurface Soil/Subsurface Sediment<sup>a</sup>

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG? <sup>b</sup>
Endrin ketone	20 - 26	5	383,250	No
gamma-BHC (Lindane)	9.80 - 13	5	31,864	No
Heptachlor	9.80 - 13	5	7,647	No
Heptachlor epoxide	9.80 - 13	5	3,782	No
Hexachlorocyclopentadiene	400 - 530	5	4.38E+06	No
Methoxychlor	98 - 130	5	4.61E+06	No
Toxaphene	200 - 260	5	31,284	No
1,2,4-Trichlorobenzene	5.50 - 530	13	1.74E+06	No
2,4,5-Trichlorophenol	2,000 - 2,600	5	9.22E+07	No
2,4,6-Trichlorophenol	400 - 530	5	3.13E+06	No
2,4-Dichlorophenol	400 - 530	5	2.76E+06	No
2,4-Dimethylphenol	400 - 530	5	1.84E+07	No
2,4-Dinitrophenol	2,000 - 2,600	4	1.84E+06	No
2,4-Dinitrotoluene	400 - 530	5	1.84E+06	No
2,6-Dinitrotoluene	400 - 530	5	921,651	No
2-Chloronaphthalene	400 - 530	5	7.37E+07	No
2-Chlorophenol	400 - 530	5	6.39E+06	No
2-Methylnaphthalene	400 - 530	5	3.69E+06	No
2-Methylphenol	400 - 530	5	4.61E+07	No
2-Nitroaniline	2,000 - 2,600	5	2.21E+06	No
2-Nitrophenol	400 - 530	5	N/A	UT
3,3'-Dichlorobenzidine	810 - 1,100	5	76,667	No
3-Nitroaniline	2,000 - 2,600	5	N/A	UT
4,6-Dinitro-2-methylphenol	2,000 - 2,600	5	92,165	No
4-Bromophenyl-phenylether	400 - 530	5	N/A	UT
4-Chloro-3-methylphenol	400 - 530	5	N/A	UT
4-Chloroaniline	400 - 530	5	3.69E+06	No
4-Chlorophenyl-phenyl ether	400 - 530	5	N/A	UT
4-Methylphenol	400 - 530	5	4.61E+06	No
4-Nitroaniline	2,000 - 2,600	5	2.39E+06	No
Acenaphthene	400 - 530	5	5.10E+07	No
Acenaphthylene	400 - 530	5	N/A	UT
Anthracene	400 - 530	5	2.55E+08	No
Benzo(a)anthracene	400 - 530	5	43,616	No
Benzo(a)pyrene	400 - 530	5	4,357	No
Benzo(b)fluoranthene	400 - 530	5	43,616	No
Benzo(g,h,i)perylene	400 - 530	5	N/A	UT
Benzo(k)fluoranthene	400 - 530	5	436,159	No
bis(2-Chloroethoxy) methane	400 - 530	5	N/A	UT
bis(2-Chloroethyl) ether	400 - 530	5	43,315	No
bis(2-Chloroisopropyl) ether	400 - 530	5	681,967	No
Butylbenzylphthalate	400 - 530	5	1.84E+08	No
Chrysene	400 - 530	5	4.36E+06	No
Di-n-octylphthalate	400 - 530	5	3.69E+07	No
Dibenz(a,h)anthracene	400 - 530	5	4,362	No

**Table A1.2**  
**Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency**  
**Less than 5 Percent in Subsurface Soil/Subsurface Sediment<sup>a</sup>**

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG?
Dibenzofuran	400 - 530	5	2.56E+06	No
Diethylphthalate	400 - 530	5	7.37E+08	No
Dimethylphthalate	400 - 530	5	9.22E+09	No
Fluoranthene	400 - 530	5	3.40E+07	No
Fluorene	400 - 530	5	3.69E+07	No
Hexachlorobenzene	400 - 530	5	21,508	No
Hexachlorobutadiene	5.50 - 530	13	255,500	No
Indeno(1,2,3-cd)pyrene	400 - 530	5	43,616	No
Isophorone	400 - 530	5	3.63E+07	No
N-Nitroso-di-n-propylamine	400 - 530	5	4,929	No
N-nitrosodiphenylamine	400 - 530	5	7.04E+06	No
Naphthalene	5.50 - 530	13	1.61E+07	No
Nitrobenzene	400 - 530	5	497,333	No
Pentachlorophenol	2,000 - 2,600	5	202,777	No
Phenanthrene	400 - 530	5	N/A	UT
Phenol	400 - 530	5	2.76E+08	No
Pyrene	400 - 530	5	2.55E+07	No
1,1,1,2-Tetrachloroethane	5.50 - 6.20	8	1.05E+06	No
1,1,1-Trichloroethane	5 - 9	21	1.06E+08	No
1,1,2,2-Tetrachloroethane	5 - 9	21	120,551	No
1,1,2-Trichloro-1,2,2-trifluoroethane	5.50 - 6.20	8	2.74E+10	No
1,1,2-Trichloroethane	5 - 9	21	322,253	No
1,1-Dichloroethane	5 - 9	21	3.12E+07	No
1,1-Dichloroethene	5 - 9	21	199,706	No
1,1-Dichloropropene	5.50 - 6.20	8	N/A	UT
1,2,3-Trichlorobenzene	5.50 - 6.20	8	N/A	UT
1,2,3-Trichloropropane	5.50 - 6.20	8	23,910	No
1,2,4-Trimethylbenzene	5.50 - 6.20	8	1.53E+06	No
1,2-Dibromo-3-chloropropane	5.50 - 6.20	8	34,137	No
1,2-Dibromoethane	5.50 - 6.20	8	403	No
1,2-Dichlorobenzene	5.50 - 530	13	3.32E+07	No
1,2-Dichloroethane	5 - 9	21	152,603	No
1,2-Dichloroethene	5 - 9	13	1.15E+07	No
1,2-Dichloropropane	5 - 9	21	441,907	No
1,3,5-Trimethylbenzene	5.50 - 6.20	8	1.31E+06	No
1,3-Dichlorobenzene	5.50 - 530	13	3.83E+07	No
1,3-Dichloropropane	5.50 - 6.20	8	N/A	UT
2,2-Dichloropropane	5.50 - 6.20	8	N/A	UT
2-Chlorotoluene	5.50 - 6.20	8	2.56E+07	No
2-Hexanone	11 - 62.1	19	N/A	UT
4-Chlorotoluene	5.50 - 6.20	8	N/A	UT
4-Isopropyltoluene	5.50 - 6.20	8	N/A	UT
Hexachloroethane	400 - 530	5	1.28E+06	No
Isopropylbenzene	5.50 - 6.20	8	375,823	No
n-Butylbenzene	5.50 - 6.20	8	N/A	UT

**Table A1.2**  
**Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency**  
**Less than 5 Percent in Subsurface Soil/Subsurface Sediment<sup>a</sup>**

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG <sup>b</sup>
n-Propylbenzene	5.50 - 6.20	8	N/A	UT
sec-Butylbenzene	5.50 - 6.20	8	N/A	UT
Styrene	5 - 9	21	1.59E+08	No
tert-Butylbenzene	5.50 - 6.20	8	N/A	UT
Tetrachloroethene	5 - 9	21	77,111	No
trans-1,2-Dichloroethene	5.50 - 6.20	8	3.30E+06	No
trans-1,3-Dichloropropene	5 - 9	21	239,434	No
Trichloroethene	5 - 9	21	20,354	No
Trichlorofluoromethane	5.50 - 6.20	8	1.74E+07	No
Vinyl acetate	11 - 18	11	3.04E+07	No
Vinyl Chloride	5.50 - 18	21	24,948	No
Xylene <sup>c</sup>	5 - 9	21	1.22E+07	No

<sup>a</sup> No analytes were detected in less than 5 percent of samples.

<sup>b</sup> Value is the maximum reported result for nondetected analytes.

<sup>c</sup> The value for total xylene is used.

N/A = Not Available.

UT = Uncertain toxicity.

**Table A1.3**  
**Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil**

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result > ESL?
<b>Inorganics (mg/kg)</b>				
Cesium	120 - 140	4	N/A	UT
Chromium (VI)	1.10 - 1.10	1	1.34	No
Thallium <sup>b</sup>	0.330 - 1.10	21	1	Yes
Uranium	1.60 - 2.20	14	5	No
<b>Organics (µg/kg)</b>				
4,4'-DDD	20 - 22	4	13,726	No
4,4'-DDE	20 - 70	4	7.95	Yes
Aldrin	10 - 11	4	47.0	No
alpha-BHC	10 - 14	4	18,662	No
alpha-Chlordane	100 - 110	4	289	No
Aroclor-1016	100 - 110	4	42.3	Yes
Aroclor-1221	100 - 110	4	42.3	Yes
Aroclor-1232	100 - 110	4	42.3	Yes
Aroclor-1242	100 - 100	4	42.3	Yes
Aroclor-1248	100 - 100	4	42.3	Yes
Aroclor-1254	200 - 220	4	42.3	Yes
Aroclor-1260	200 - 220	4	42.3	Yes
beta-BHC	10 - 11	4	207	No
beta-Chlordane	100 - 110	4	289	No
Dieldrin	20 - 25	4	7.40	Yes
Endosulfan I	10 - 11	4	80.1	No
Endosulfan II	20 - 22	4	80.1	No
Endosulfan sulfate	20 - 29	4	80.1	No
Endrin	20 - 22	4	1.40	Yes
Endrin ketone	20 - 22	4	1.40	Yes
gamma-BHC (Lindane)	10 - 11	4	25.9	No
Heptachlor	10 - 11	4	63.3	No
Heptachlor epoxide	10 - 14	4	64.0	No
Hexachlorocyclopentadiene	410 - 450	4	5,518	No
Methoxychlor	100 - 110	4	1,226	No
Toxaphene	200 - 220	4	3,756	No
1,2,4-Trichlorobenzene	5.80 - 450	12	777	No
2,4,5-Trichlorophenol	2,000 - 2,200	4	4,000	No
<b>2,4,6-Trichlorophenol</b>	<b>410 - 450</b>	<b>4</b>	<b>161</b>	<b>Yes</b>
2,4-Dichlorophenol	410 - 450	4	2,744	No
2,4-Dimethylphenol	410 - 450	4	N/A	UT
2,4-Dinitrophenol	2,000 - 2,200	4	20,000	No
<b>2,4-Dinitrotoluene</b>	<b>410 - 450</b>	<b>4</b>	<b>32.1</b>	<b>Yes</b>
2,6-Dinitrotoluene	410 - 450	4	6,186	No
2-Chloronaphthalene	410 - 450	4	N/A	UT
<b>2-Chlorophenol</b>	<b>410 - 450</b>	<b>4</b>	<b>281</b>	<b>Yes</b>
2-Methylnaphthalene	410 - 450	4	2,769	No
2-Methylphenol	410 - 450	4	123,842	No
2-Nitroaniline	2,000 - 2,200	4	5,659	No

**Table A1.3**  
**Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil**

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result > ESL? <sup>a</sup>
2-Nitrophenol	410 - 450	4	N/A	UT
3,3'-Dichlorobenzidine	830 - 900	4	N/A	UT
3-Nitroaniline	2,000 - 2,100	3	N/A	UT
<b>4,6-Dinitro-2-methylphenol</b>	<b>2,000 - 2,200</b>	<b>4</b>	<b>560</b>	<b>Yes</b>
4-Bromophenyl-phenylether	410 - 450	4	N/A	UT
4-Chloro-3-methylphenol	410 - 450	4	N/A	UT
4-Chloroaniline	410 - 450	4	716	No
4-Chlorophenyl-phenyl ether	410 - 450	4	N/A	UT
4-Methylphenol	410 - 450	4	N/A	UT
4-Nitroaniline	2,000 - 2,200	4	41,050	No
4-Nitrophenol	2,000 - 2,200	4	7,000	No
Acenaphthene	410 - 450	4	20,000	No
Acenaphthylene	410 - 450	4	N/A	UT
Anthracene	410 - 450	4	N/A	UT
Benzo(a)anthracene	410 - 450	4	N/A	UT
Benzo(a)pyrene	410 - 450	4	631	No
Benzo(b)fluoranthene	410 - 450	4	N/A	UT
Benzo(g,h,i)perylene	410 - 450	4	N/A	UT
Benzo(k)fluoranthene	410 - 450	4	N/A	UT
Benzyl Alcohol	410 - 450	4	4,403	No
bis(2-Chloroethoxy) methane	410 - 450	4	N/A	UT
bis(2-Chloroethyl) ether	410 - 450	4	N/A	UT
bis(2-Chloroisopropyl) ether	410 - 450	4	N/A	UT
Butylbenzylphthalate	410 - 450	4	24,155	No
Chrysene	410 - 450	4	N/A	UT
<b>Di-n-butylphthalate</b>	<b>410 - 450</b>	<b>4</b>	<b>15.9</b>	<b>Yes</b>
Di-n-octylphthalate	410 - 450	4	731,367	No
Dibenz(a,h)anthracene	410 - 450	4	N/A	UT
Dibenzofuran	410 - 450	4	21,200	No
Diethylphthalate	410 - 450	4	100,000	No
Dimethylphthalate	410 - 450	4	200,000	No
Fluoranthene	410 - 450	4	N/A	UT
Fluorene	410 - 450	4	30,000	No
<b>Hexachlorobenzene</b>	<b>410 - 450</b>	<b>4</b>	<b>7.73</b>	<b>Yes</b>
<b>Hexachlorobutadiene</b>	<b>5.80 - 450</b>	<b>12</b>	<b>431</b>	<b>Yes</b>
Indeno(1,2,3-cd)pyrene	410 - 450	4	N/A	UT
Isophorone	410 - 450	4	N/A	UT
N-Nitroso-di-n-propylamine	410 - 450	4	N/A	UT
N-nitrosodiphenylamine	410 - 450	4	20,000	No
Naphthalene	5.80 - 450	12	27,048	No
Nitrobenzene	410 - 450	4	40,000	No
<b>Pentachlorophenol</b>	<b>2,000 - 2,200</b>	<b>4</b>	<b>122</b>	<b>Yes</b>
Phenanthrene	410 - 450	4	N/A	UT
Phenol	410 - 450	4	23,090	No
Pyrene	410 - 450	4	N/A	UT

**Table A1.3**  
**Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection**  
**Frequency Less than 5 Percent in Surface Soil**

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result > ESL?
1,1,1,2-Tetrachloroethane	5.80 - 6.40	8	N/A	UT
1,1,1-Trichloroethane	5.80 - 6.40	8	551,453	No
1,1,2,2-Tetrachloroethane	5.80 - 6.40	8	60,701	No
1,1,2-Trichloro-1,2,2-trifluoroethane	5.80 - 6.40	8	N/A	UT
1,1,2-Trichloroethane	5.80 - 6.40	8	N/A	UT
1,1-Dichloroethane	5.80 - 6.40	8	3,121	No
1,1-Dichloroethene	5.80 - 6.40	8	16,909	No
1,1-Dichloropropene	5.80 - 6.40	8	N/A	UT
1,2,3-Trichlorobenzene	5.80 - 6.40	8	N/A	UT
1,2,3-Trichloropropane	5.80 - 6.40	8	13,883	No
1,2,4-Trimethylbenzene	5.80 - 6.40	8	N/A	UT
1,2-Dibromo-3-chloropropane	5.80 - 6.40	8	N/A	UT
1,2-Dibromoethane	5.80 - 6.40	8	N/A	UT
1,2-Dichlorobenzene	5.80 - 450	12	N/A	UT
1,2-Dichloroethane	5.80 - 6.40	8	2,764	No
1,2-Dichloropropane	5.80 - 6.40	8	49,910	No
1,3,5-Trimethylbenzene	5.80 - 6.40	8	7,598	No
1,3-Dichlorobenzene	5.80 - 450	12	N/A	UT
1,3-Dichloropropane	5.80 - 6.40	8	N/A	UT
2,2-Dichloropropane	5.80 - 6.40	8	N/A	UT
2-Butanone	116 - 128	8	1.07E+06	No
2-Chlorotoluene	5.80 - 6.40	8	N/A	UT
2-Hexanone	57.8 - 64.2	8	N/A	UT
4-Chlorotoluene	5.80 - 6.40	8	N/A	UT
4-Isopropyltoluene	5.80 - 6.40	8	N/A	UT
4-Methyl-2-pentanone	57.8 - 64.2	8	14,630	No
Acetone	116 - 128	8	6,182	No
Benzene	5.80 - 6.40	8	500	No
Bromobenzene	5.80 - 6.40	8	N/A	UT
Bromochloromethane	5.80 - 6.40	8	N/A	UT
Bromodichloromethane	5.80 - 6.40	8	5,750	No
Bromoform	5.80 - 6.40	8	2,855	No
Bromomethane	5.80 - 6.40	8	N/A	UT
Carbon Disulfide	5.80 - 6.40	8	5,676	No
Carbon Tetrachloride	5.80 - 6.40	8	8,906	No
Chlorobenzene	5.80 - 6.40	8	4,750	No
Chloroethane	5.80 - 6.40	8	N/A	UT
Chloroform	5.80 - 6.40	8	8,655	No
Chloromethane	5.80 - 6.40	8	N/A	UT
cis-1,2-Dichloroethene	5.80 - 6.40	8	1,814	No
cis-1,3-Dichloropropene	5.80 - 6.40	8	2,800	No
Dibromochloromethane	5.80 - 6.40	8	5,730	No
Dibromomethane	5.80 - 6.40	8	N/A	UT
Dichlorodifluoromethane	5.80 - 6.40	8	855	No
Ethylbenzene	5.80 - 6.40	8	N/A	UT

**Table A1.3**  
**Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil**

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result > ESL? <sup>a</sup>
Hexachloroethane	410 - 450	4	366	Yes
Isopropylbenzene	5.80 - 6.40	8	N/A	UT
n-Butylbenzene	5.80 - 6.40	8	N/A	UT
n-Propylbenzene	5.80 - 6.40	8	N/A	UT
sec-Butylbenzene	5.80 - 6.40	8	N/A	UT
Styrene	5.80 - 6.40	8	16,408	No
tert-Butylbenzene	5.80 - 6.40	8	N/A	UT
Toluene	5.80 - 6.40	8	14,416	No
trans-1,2-Dichloroethene	5.80 - 6.40	8	25,617	No
trans-1,3-Dichloropropene	5.80 - 6.40	8	2,800	No
Trichloroethene	5.80 - 6.40	8	389	No
Trichlorofluoromethane	5.80 - 6.40	8	N/A	UT
Vinyl Chloride	5.80 - 6.40	8	97.7	No
Xylene <sup>c</sup>	5.80 - 6.40	8	1,140	No

<sup>a</sup> Value is the maximum reported result for nondetected analytes.

<sup>b</sup> Analyte has a detection frequency of less than 5 %.

<sup>c</sup> The value for total xylene is used.

N/A = Not Available.

UT = Uncertain toxicity.

**Table A1.4**  
**Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection**  
**Frequency Less than 5 Percent in Subsurface Soil<sup>a</sup>**

Analyte	Range of Reported Results	Total Number of Results	Prairie Dog NOAEL/ESL	Maximum Reported Result > ESL?
<b>Inorganics (mg/kg)</b>				
Antimony	0.510 - 15.1	13	18.7	No
Cadmium	0.430 - 0.997	14	198	No
<b>Organics (µg/kg)</b>				
1,1,1,2-Tetrachloroethane	5.50 - 6.20	8	N/A	UT
1,1,1-Trichloroethane	5 - 6.20	16	4.85E+07	No
1,1,2,2-Tetrachloroethane	5 - 6.20	16	4.70E+06	No
1,1,2-Trichloro-1,2,2-trifluoroethane	5.50 - 6.20	8	N/A	UT
1,1,2-Trichloroethane	5 - 6.20	16	N/A	UT
1,1-Dichloroethane	5 - 6.20	16	215,360	No
1,1-Dichloroethene	5 - 6.20	16	1.28E+06	No
1,1-Dichloropropene	5.50 - 6.20	8	N/A	UT
1,2,3-Trichlorobenzene	5.50 - 6.20	8	N/A	UT
1,2,3-Trichloropropane	5.50 - 6.20	8	1.17E+06	No
1,2,4-Trichlorobenzene	5.50 - 6.20	8	94,484	No
1,2,4-Trimethylbenzene	5.50 - 6.20	8	N/A	UT
1,2-Dibromo-3-chloropropane	5.50 - 6.20	8	N/A	UT
1,2-Dibromoethane	5.50 - 6.20	8	N/A	UT
1,2-Dichlorobenzene	5.50 - 6.20	8	N/A	UT
1,2-Dichloroethane	5 - 6.20	16	2.00E+06	No
1,2-Dichloroethene	5 - 6	8	1.87E+06	No
1,2-Dichloropropane	5 - 6.20	16	3.92E+06	No
1,3,5-Trimethylbenzene	5.50 - 6.20	8	855,709	No
1,3-Dichlorobenzene	5.50 - 6.20	8	N/A	UT
1,3-Dichloropropane	5.50 - 6.20	8	N/A	UT
2,2-Dichloropropane	5.50 - 6.20	8	N/A	UT
2-Butanone	11 - 124	14	4.94E+07	No
2-Chlorotoluene	5.50 - 6.20	8	N/A	UT
2-Hexanone	11 - 62.1	14	N/A	UT
4-Chlorotoluene	5.50 - 6.20	8	N/A	UT
4-Isopropyltoluene	5.50 - 6.20	8	N/A	UT
4-Methyl-2-pentanone	11 - 62.1	14	859,131	No
Benzene	5 - 6.20	16	1.10E+06	No
Bromobenzene	5.50 - 6.20	8	N/A	UT
Bromochloromethane	5.50 - 6.20	8	N/A	UT
Bromodichloromethane	5 - 6.20	16	381,135	No
Bromoform	5 - 6.20	16	198,571	No
Bromomethane	5.50 - 12	15	N/A	UT
Carbon Disulfide	5 - 6.20	16	410,941	No
Carbon Tetrachloride	5 - 6.20	16	736,154	No
Chlorobenzene	5 - 6.20	16	413,812	No
Chloroethane	5.50 - 12	15	N/A	UT
Chloroform	5 - 6.20	16	560,030	No
Chloromethane	5.50 - 12	16	N/A	UT
cis-1,2-Dichloroethene	5.50 - 6.20	8	132,702	No

**Table A1.4**  
**Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection**  
**Frequency Less than 5 Percent in Subsurface Soil<sup>a</sup>**

Analyte	Range of Reported Results	Total Number of Results	Prairie Dog NOAEL/ESL	Maximum Reported Result > ESL? <sup>b</sup>
cis-1,3-Dichloropropene	5 - 6.20	16	222,413	No
Dibromochloromethane	5 - 6.20	16	389,064	No
Dibromomethane	5.50 - 6.20	8	N/A	UT
Dichlorodifluoromethane	5.50 - 6.20	8	59,980	No
Ethylbenzene	5 - 6.20	16	N/A	UT
Hexachlorobutadiene	5.50 - 6.20	8	150,894	No
Isopropylbenzene	5.50 - 6.20	8	N/A	UT
Naphthalene	5.50 - 6.20	8	1.60E+07	No
n-Butylbenzene	5.50 - 6.20	8	N/A	UT
n-Propylbenzene	5.50 - 6.20	8	N/A	UT
sec-Butylbenzene	5.50 - 6.20	8	N/A	UT
Styrene	5 - 6.20	16	1.53E+06	No
tert-Butylbenzene	5.50 - 6.20	8	N/A	UT
Tetrachloroethene	5 - 6.20	16	72,494	No
trans-1,2-Dichloroethene	5.50 - 6.20	8	1.87E+06	No
trans-1,3-Dichloropropene	5 - 6.20	16	222,413	No
Trichloroethene	5 - 6.20	16	32,424	No
Trichlorofluoromethane	5.50 - 6.20	8	N/A	UT
Vinyl acetate	11 - 12	6	730,903	No
Vinyl chloride	5.50 - 12	16	6,494	No
Xylene <sup>c</sup>	5 - 6.20	16	111,663	No

<sup>a</sup> No analytes were detected in less than 5 percent of samples.

<sup>b</sup> Value is the maximum reported result for nondetected analytes.

<sup>c</sup> The value for total xylene is used.

N/A = Not Available.

UT = Uncertain toxicity.

**COMPREHENSIVE RISK ASSESSMENT**

**LOWER WALNUT DRAINAGE EXPOSURE UNIT**

**VOLUME 8: ATTACHMENT 2**

**Data Quality Assessment**

## TABLE OF CONTENTS

<b>ACRONYMS AND ABBREVIATIONS.....</b>	<b>iii</b>
<b>EXECUTIVE SUMMARY .....</b>	<b>ES-1</b>
<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 ANALYTICAL DATA .....</b>	<b>2</b>
<b>3.0 FINDINGS.....</b>	<b>4</b>
3.1 Dioxins and Furans – Water .....	4
3.2 Herbicides – Water .....	4
3.3 Metals – Soil .....	5
3.4 Metals – Water.....	5
3.5 Polychlorinated Biphenyls (PCBs) – Soil.....	5
3.6 Polychlorinated Biphenyls – Water .....	5
3.7 Pesticides – Soil .....	5
3.8 Pesticides – Water.....	6
3.9 Radionuclides – Soil .....	6
3.10 Radionuclides – Water.....	6
3.11 Semi-Volatile Organic Compounds (SVOCs) – Soil .....	6
3.12 Semi-Volatile Organic Compounds – Water .....	6
3.13 Volatile Organic Compounds (VOCs) – Soil .....	7
3.14 Volatile Organic Compounds – Water.....	7
3.15 Wet Chemistry Parameters – Soil .....	7
3.16 Wet Chemistry Parameters – Water.....	7
<b>4.0 CONCLUSIONS .....</b>	<b>7</b>
<b>5.0 REFERENCES.....</b>	<b>9</b>

## LIST OF TABLES

Table A2.1	CRA Data V&V Summary
Table A2.2	V&V Qualifier Flag Definitions
Table A2.3	V&V Reason Code Definitions
Table A2.4	Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters
Table A2.5	Summary of V&V Observations
Table A2.6	Summary of Data Rejected During V&V
Table A2.7	Summary of RPDs/DERs of Field Duplicate Analyte Pairs
Table A2.8	Summary of Data Estimated or Undetected Due to V&V Determinations
Table A2.9	Summary of Data Qualified as Undetected Due to Blank Contamination

## ACRONYMS AND ABBREVIATIONS

AA	atomic absorption
AI	adequate intake
ASD	Analytical Services Division
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
CRDL	contract required detection limit
DER	duplicate error ratio
DQA	Data Quality Assessment
DQO	data quality objective
DRC	data review checklist
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EU	Exposure Unit
IAG	Interagency Agreement
ICP	inductively couple plasma
IDL	instrument detection limit
LCS	laboratory control sample
LWNEU	Lower Walnut Drainage Exposure Unit
MDA	minimum detectable activity
MDL	method detection limit
MS	matrix spike
MSA	method of standard additions

MSD	matrix spike duplicate
NIST	National Institute of Standards Technology
PARCC	precision, accuracy, representativeness, completeness, and comparability
PPT	pipette
PCB	polychlorinated biphenyl
QC	quality control
RDL	required detection limit
RFEDS	Rocky Flats Environmental Data System
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
RPD	relative percent difference
SDP	standard data package
SOW	Statement of Work
SVOC	semi-volatile organic compound
SWD	Soil Water Database
TCLP	Toxicity Characteristic Leaching Procedure
TIC	tentatively identified compound
V&V	verification and validation
VOC	volatile organic compound

## EXECUTIVE SUMMARY

This document provides an assessment of the quality of the data used in the Lower Walnut Drainage Exposure Unit (LWNEU) Comprehensive Risk Assessment (CRA). This Data Quality Assessment (DQA) focuses on all elements of quality control (QC) including both laboratory and sample-specific QC data.

Depending on the matrix and analyte group, anywhere from 27 to 100 percent of the LWNEU data have been verified and/or validated by a validator from the Analytical Services Division (ASD) at the Rocky Flats Environmental Technology Site (RFETS) (or from an outside subcontractor) using verification and validation (V&V) guidelines for each analytical method developed for RFETS. V&V data are identified in the RFETS Soil Water Database (SWD) by a data qualifier flag and reason code(s) that provide an explanation for the qualifier flag. All rejected data have been removed from the dataset used in the CRA because the validator has determined the data are unusable. The remaining V&V data have associated qualifier flags indicating that the data are valid, estimated, or undetected, and are used in the CRA. Of the LWNEU V&V data, approximately 13 percent was qualified as estimated and/or undetected. Approximately 3 percent of the data reported as detected by the laboratory were qualified as undetected due to blank contamination. Data qualified as estimated or undetected are a result of various minor laboratory noncompliance issues that are insufficient to render the data unusable.

A review of the LWNEU V&V data indicates that the data meet the data quality objectives (DQOs) outlined in the Final CRA Work Plan and Methodology (K-H 2004) (hereafter referred to as the CRA Methodology). A review of the most common observations found in the V&V data determined that a minimal amount, less than 1 percent, of the non-V&V data may have been qualified if a review had been performed. Based on this DQA, data for the LWNEU are of sufficient quality for use in the CRA.

## 1.0 INTRODUCTION

The Lower Walnut Drainage Exposure Unit (EU) (LWNEU) Comprehensive Risk Assessment (CRA) for the Rocky Flats Environmental Technology Site (RFETS) has been prepared in accordance with the CRA Methodology. The CRA Methodology was developed jointly with the regulatory agencies using the consultative process, and was approved by the agencies on September 28, 2004. Consistent with the CRA Methodology, data quality was assessed using a standard precision, accuracy, representativeness, completeness, and comparability (PARCC) parameter analysis (EPA 2002). Both laboratory and field quality control (QC) were evaluated for the LWNEU data set.

Although many of the elements of QC that are reviewed in this document affect more than one PARCC parameter, their major impact on data quality is described below:

- Precision, as a measure of agreement among replicate measurements, is determined quantitatively based on the results of replicate laboratory measurements. Precision of the laboratory data was verified through review of:
  - Relative percent differences (RPDs) for laboratory control samples (LCSs) and LCS duplicates compared to the acceptable ranges (analytical precision);
  - RPDs (nonradionuclides) and duplicate error ratios (DERs) (radionuclides) for field sample and field duplicates compared to the acceptable ranges<sup>1</sup> (field precision);
  - RPDs for matrix spike (MS) and matrix spike duplicates (MSDs) compared to acceptable control ranges (matrix precision); and
  - RPDs for primary- and second-column analyses (analytical precision).
- Accuracy, as a measure of the distortion of a measurement process that causes error in measuring the true value, is determined quantitatively based on the analysis of samples with a known concentration. Accuracy of the laboratory data was verified through review of:
  - LCS data, calibration verification data, internal standard data, and instrument tune parameters (laboratory accuracy); and
  - Surrogate recoveries, MSs, and sample preparation (sample-specific accuracy).

<sup>1</sup> The CRA Methodology states that the overall precision of the data is considered adequate if the RPD between the target and duplicate, at concentrations five times the reporting limit (RL), is less than 35 percent for solids and 20 percent for liquids. The precision adequacy requirement for radiological contaminants is a DER less than 1.96.

- Representativeness of the data was verified through review of:
  - Laboratory blank data;
  - Sample preservation/storage;
  - Adherence to sample holding times;
  - Documentation issues;
  - Contract noncompliance issues; and
  - Laboratory activities affecting ability to properly identify compounds.
- Completeness is a data adequacy criterion and is addressed in Appendix A, Volume 2 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report). It refers to the spatial and temporal distribution of the data, and their adequacy for estimating exposure point concentrations (EPCs) for the CRA.
- Comparability of the data was verified through evaluation of:
  - Analytical procedures, and whether they were standard U.S. Environmental Protection Agency (EPA)- and RFETS-approved procedures;
  - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and
  - MS and surrogate samples, ensuring accuracy within acceptable ranges.

## 2.0 ANALYTICAL DATA

Approximately 20,000 specific analytical records exist in the LWNEU CRA data set, some 77 percent of which (15,161 records) have undergone V&V. The fraction of the data that was verified and/or validated is shown in Table A2.1 by analyte group and matrix. These data were reviewed by validators and their observations and comments are captured in the Soil Water Database (SWD). All of the data that have been flagged due to V&V findings (except “R”-flagged data) and data that have no flags as a result of V&V are used in the LWNEU CRA. The small amount of data that has not undergone V&V is used as provided by the laboratories. The most common errors found during V&V such as transcription errors, calculation errors, and excluded records that were later added by the validator were reviewed to determine the possible effect on non-V&V data. Assuming that the percentage of data qualified as a result of these issues are representative of similar observations in the non-V&V data, less than 1 percent of the entire LWNEU dataset is at risk for such un-acknowledged and therefore un-corrected errors.

Data V&V involves an in-depth review of the data packages from the laboratory to assess compliance with contract requirements. In general, data validation includes all of the activities of verification, as well as additional QC checks and review of some raw laboratory instrument data and calculations. After V&V, a data qualifier flag and/or reason code(s) are assigned to the data record (Tables A2.2 and A2.3). The reason codes provide an explanation for the qualifier flag, thereby making it possible to determine which of the PARCC parameters is affected by the observation (Table A2.4). Qualifier flags are discussed in this Data Quality Assessment (DQA) as those V&V flags that note issues in the data. V&V flags "V", "V1", and "1" represent data that were reviewed by validators, but no issues were observed. Eighty-three percent of the V&V data fall into this category. Additional qualifier flags such as "A", "E", and "Z" were also applied. These validation qualifiers are notations that do not indicate estimation or a change in the status of detection. The data are valid and useable as reported by the laboratory. Four percent of the V&V data are represented by these additional qualifier flags. The specific definitions of these additional V&V flags are presented in Table A2.2. Data with noted issues are presented in Table A2.5 and discussed in detail in Section 3.0.

V&V qualifier flags are not specifically addressed in this data assessment, but rather the reason codes associated with the qualifier flags for each analytical record are summarized and evaluated. This approach was chosen because the validator's specific observations (reason codes), and not the qualifier flags, provide the best descriptors of the data quality.

V&V data records contain a field with V&V reason codes (5, 18/52, 200, 99/101/701, and so forth), or the field is null. These reason codes represent observations related to assessment of precision, accuracy, and representativeness. For example, the reason code 110 definition (see Table A2.3) is "LCS recovery criteria were not met", which is an observation related to data accuracy.

Multiple reason codes were routinely applied to a specific sample method/matrix/analyte combination. Therefore, it was necessary to parse out the individual codes to create a table that included a unique record identifier and the associated parsed data V&V reason code (5, 18, 52, 200, 99, 101, 701, and so forth). With this information and the data V&V reason code definitions, the data validator's observations related to this data set can be re-created for each analytical record.

To summarize the reason codes in a logical manner for presentation, it was first necessary to group the reason codes that have slightly different definitions but convey the same meaning. A standardized definition was then applied to the individual reason codes within the group. The grouped reason codes were also assigned a QC category (for example, blanks, calibration, and holding time), and the affected PARCC parameter (Table A2.4). The reason codes were then summarized for each medium and analyte group within each QC category, applying the standardized definition to the summarized codes. The summary is presented in Table A2.5.

Rejected data (data qualifier flag, "R"), consisting of less than 3 percent of all V&V data, have been removed from the data used in the LWNEU CRA because the validator has

determined the data to be unusable. The fraction of the data that was rejected during validation and/or verification is shown in Table A2.6 by analyte group and matrix.

Finally, evaluating the RPD (DER for radionuclides) between a target sample and the associated field duplicate is not a QC parameter performed during V&V, but is still an important analysis when determining data precision. Because this analysis was not performed during V&V, the target sample/field duplicate RPD and DER calculations were performed separately and are presented in Table A2.7 as the number of exceedances per analyte group/matrix combination. Only those analyte group/matrix combinations having records that met the criteria for calculating an RPD or DER are presented. RPDs and DERs for target sample/field duplicate analyte pairs where one or both of the results are less than five times the RL are not calculated as outlined in the CRA Methodology.

### **3.0 FINDINGS**

V&V observations affecting the CRA data set are summarized by analyte group/matrix/QC category/V&V observation in Table A2.5. The detected and nondetected results are summarized separately to give the reader a better idea of the impact on data usability. Only those issues observed in notable percentages (generally greater than 5 percent) of the data are discussed below in further detail. RPDs (DERs for radionuclides) presented in Table A2.7 are only discussed below when RPD (DER for radionuclides) exceedances of control criteria are greater than 10 percent for any give analyte group/matrix combination. Instances of elevated rates (greater than 10 percent) of rejected data are also discussed below.

#### **3.1 Dioxins and Furans – Water**

Documentation issues resulted in data V&V qualifications related to this analyte group/matrix combination. While the percentage of the data qualified due to transcription errors is high, the data quality is not impacted. All transcription errors have previously been evaluated and corrected. Fifteen percent of the V&V data for this analyte group/matrix combination was rejected, but 100 percent of all associated data underwent V&V. Consequently there is no possibility that any rejected data related to this analyte group and matrix were used in CRA.

#### **3.2 Herbicides – Water**

Documentation issues resulted in data V&V qualifications related to this analyte group/matrix combination. While the percentage of the data qualified due to transcription errors is high, the data quality is not impacted. All transcription errors have previously been evaluated and corrected. Approximately 26 percent of the V&V data for this analyte group/matrix combination were rejected. Taking into account that only 27 percent of the CRA data associated with this analyte group and matrix was either validated and/or verified, as much as 19 percent of the data used in the CRA may have been rejected if a review had been performed. Although 19 is a high percentage, it is important to note that

only 41 total records exist in the LWNEU CRA dataset for this analyte group and matrix. In addition, only six of 23 total V&V records were rejected. Such a small dataset can skew statistics, but no systematic problem is indicated.

### **3.3 Metals – Soil**

Blank, calibration, documentation, holding time, instrument set-up, LCS, matrix, sensitivity, and other observations resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to issues with sample matrices and expired instrument detection limit (IDL) studies. While the importance of these QC parameters should not be overlooked, it is also important to note that the data were qualified as usable, although estimated. Although greater than 11 percent of the target sample/field duplicate analyte pairs exceeded RPD criteria, it is important to note that the majority of exceedances were noted in only two samples, with only four samples being affected overall. While this may indicate some issue with matrix interference in these samples, the impact on data precision is minimal.

### **3.4 Metals – Water**

Blank, calculation error, calibration, documentation, holding time, instrument set-up, LCS, matrix, sample preparation, sensitivity, and other observations resulted in V&V qualifications associated with this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

### **3.5 Polychlorinated Biphenyls (PCBs) – Soil**

Surrogate issues resulted in data V&V observations related to this analyte group/matrix combination. While the percentage of observations is high, it is important to note that the data were qualified as usable, although estimated.

### **3.6 Polychlorinated Biphenyls – Water**

Documentation and surrogate issues resulted in data V&V observations related to this analyte group/matrix combination. Errors in key data fields have no impact on data quality as all issues have previously been evaluated and corrected. While the importance of surrogate analyses should not be overlooked, it is important to note that the data were qualified as usable, although estimated.

### **3.7 Pesticides – Soil**

Surrogate issues resulted in data V&V observations related to this analyte group/matrix combination. While the percentage of observations is high, it is important to note that the data were qualified as usable, although estimated.

### **3.8 Pesticides – Water**

Calibration, documentation, internal standard, and surrogate issues resulted in V&V qualification related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to errors in key data fields and low surrogate recoveries. Errors in key data fields have no impact on data quality as all issues have previously been evaluated and corrected. While the importance of surrogate analyses should not be overlooked, it is important to note that the data were qualified as usable, although estimated.

### **3.9 Radionuclides – Soil**

Blank, calculation error, calibration, documentation, instrument set-up, LCS, matrix, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to insufficient documentation or because the minimum detectable activity (MDA) of the instrument was calculated by the reviewer. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Validator-calculated MDAs have no effect on data quality as all issues have previously been evaluated and corrected.

### **3.10 Radionuclides – Water**

Blank, calculation error, calibration, documentation, holding time, instrument set-up, LCS, matrix, sample preparation, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

### **3.11 Semi-Volatile Organic Compounds (SVOCs) – Soil**

Blank, calibration, and internal standard observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low and within method expectations.

### **3.12 Semi-Volatile Organic Compounds – Water**

Blank, calibration, documentation, holding time, instrument set-up, internal standard, LCS, and sample preparation issues resulted in V&V observations related to this analyte group/matrix combination. With the exception of those records qualified because due to transcription errors, the percentage of observations is low and within method expectations. Transcription errors have no impact on data quality, as all issues have previously been evaluated and corrected.

### **3.13 Volatile Organic Compounds (VOCs) – Soil**

Blank, calibration, holding time, internal standard, and surrogate issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

### **3.14 Volatile Organic Compounds – Water**

Blank, calibration, documentation, holding time, instrument set-up, internal standard, LCS, and sample preparation issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to omissions in the data package and holding time exceedances. The omissions or errors noted in the data package do not impact data quality as the omitted data was not required for V&V. While the importance of observing allowed sample holding times should not be overlooked, it is important to note that the results were not qualified as the holding time being grossly exceeded, as was the practice if appropriate and the data were qualified as usable, although estimated.

### **3.15 Wet Chemistry Parameters – Soil**

Documentation, holding time, matrix, sample preparation, and other issues resulted in V&V observations related to this analyte group/matrix combination. While the percentage of several of the observations is high, it is important to note that this analyte group contains numerous general chemistry parameters having little or no impact on site characterization.

### **3.16 Wet Chemistry Parameters – Water**

Blank, calculation error, documentation, holding time, matrix, sample preparation, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

## **4.0 CONCLUSIONS**

The quality of the laboratory results were evaluated for compliance with the CRA Methodology data quality objectives (DQOs) through an overall review of PARCC parameters.

Of the data used in the LWNEU CRA, approximately 77 percent underwent the V&V process. Of that 77 percent, 83 percent was qualified as having no QC issues, and approximately 13 percent was qualified as estimated or undetected (Table A2.8). The remaining 4 percent of the V&V data are made up of records qualified with additional flags indicating acceptable data such as “A”, “E”, or “P”. Approximately 3 percent of the data reported as detected by the laboratory were flagged as undetected by the validators due to blank contamination (Table A2.9). Data qualified as estimated or undetected

indicate some issues with PARCC parameters, but not to a degree sufficient to mark the data unusable. Less than 3 percent of the entire data set was rejected during the V&V process (Table A2.6).

Although many of the elements of QC that are reviewed in this document affect more than one PARCC parameter, the general discussion below summarizes the data quality per the validation reason codes affecting each specific PARCC parameter. Several V&V reason codes have no real impact on data quality because they represent issues that were noted but corrected, or represent observations related to missing documentation that was not required for data assessment. Approximately 11 percent of the LWNEU V&V data were flagged with these “Other” V&V observations.

- Precision, as a measure of agreement among replicate measurements, is determined quantitatively based on the results of replicate laboratory measurements.

Of the V&V data, approximately 2 percent was noted for observations related to precision. Of that 2 percent, 100 percent was qualified for issues related to sample matrices. No result confirmation, LCS or instrument sensitivity or set-up issues related to precision were noted.

RPDs and DERs for target sample/field duplicate pairs were found to be acceptable for all analyte group/matrix combinations. Overall, the method precision was found to be generally acceptable.

- Accuracy is a measure of the distortion of a measurement process that causes error in the true value.

Of the V&V data, 27 percent was noted for accuracy-related observations. Of that 27 percent, 69 percent was noted for laboratory practice-related observations, while sample-specific accuracy observations make up the other 31 percent. Although the percentage of data with noted accuracy issues is slightly elevated, it is important to note that most of the data flagged with these accuracy-related observations are also flagged as estimated and the CRA is performed with this uncertainty in mind.

Accuracy was generally acceptable with infrequent performance outside QC limits.

- Representativeness of the data was verified.

Of the V&V data, approximately 30 percent was noted for observations related to representativeness. Of that 30 percent, 71 percent was qualified for blank observations, 18 percent for failure to observe allowed holding times, 4 percent for sample preparation issues, and 4 percent for documentation issues. Instrument set-up and sensitivity, LCS, and other observations make up the other 3 percent of the data qualified for observations related to sample representativeness.

Reportable levels of target analytes were not routinely detected in the laboratory blanks greater than the laboratory RLs except for relatively isolated incidences. Samples were generally stored and preserved properly. Overall, these elements of QC exceedances are indicative of normal laboratory operations and have little impact the sample data as reported.

Sample data are representative of the site conditions at the time of sample collection.

- Comparability of the data was reviewed and no systematic errors were noted.
  - The use of standard EPA- and RFETS-approved analytical procedures;
  - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and
  - Evaluation of MS and surrogate samples, ensuring accuracy within acceptable ranges.

Examination of these parameters did not show any systematic issues with comparability.

- Completeness, as defined in the CRA Methodology, is addressed in Appendix A, Volume 2 of the RI/FS Report.

Another indication of completeness that is sometimes used is a measure of the number of valid measurements obtained in relation to the total number of measurements planned.

Because less than 3 percent of the overall data were rejected, the use of non-V&V data for the LWNEU CRA does not contribute to any completeness issues.

This review concludes that the PARCC of the data are generally acceptable and the CRA objectives have been met.

## 5.0 REFERENCES

K-H, 2004. Final Comprehensive Risk Assessment Work Plan and Methodology, Environmental Restoration, Rocky Flats Environmental Technology Site, Golden, Colorado. September.

EPA, 2002. Guidance for Quality Assurance Project Plans. EPA QA/G-5, EPA/240/R-02/009. Office of Environmental Information, Washington, D.C. December.

## TABLES

**Table A2.1**  
**CRA Data V&V Summary**

Analyte Group	Matrix	Total No. of V&V Records	Total No. of CRA Records	Percent V&V (%)
Dioxins and Furans	WATER	3	3	100
Herbicide	SOIL	12	12	100
Herbicide	WATER	11	41	26.8
Metal	SOIL	1,397	1,397	100
Metal	WATER	3,967	4,542	87.3
PCB	SOIL	84	84	100
PCB	WATER	28	56	50
Pesticide	SOIL	251	252	99.6
Pesticide	WATER	92	203	45.3
Radionuclide	SOIL	390	452	86.3
Radionuclide	WATER	1,973	3,962	49.8
SVOC	SOIL	751	754	99.6
SVOC	WATER	747	1,023	73.0
VOC	SOIL	1,490	1,558	95.6
VOC	WATER	2,940	3,776	77.9
Wet Chemistry	SOIL	35	35	100
Wet Chemistry	WATER	990	1,592	62.2
	<b>Total</b>	<b>15,161</b>	<b>19,742</b>	<b>0.768</b>

**Table A2.2**  
**V&V Qualifier Flag Definitions**

Validation Qualifier Code	Description
I	QC data from a data package – Verification
A	Data acceptable with qualifications
B	Compound was found in BLK and sample
C	Calibration
E	Associated value exceeds calibration range; dilute and reanalyze
J	Estimated quantity – Validation
J1	Estimated quantity – Verification
JB	Organic method blank contamination – Validation
JB1	Organic method blank contamination – Verification
N	Historical – Validators asked not to validate this
NJ	Associated value is presumptively estimated
NJ1	Value presumptively estimated – Verification
P	Systematic error
R	Data unusable – Validation
R1	Data unusable – Verification
S	Matrix spike
U	Analyzed, not detected at/above method detection limit
U1	Analyzed, not detect at/above method detection limit – Verification
UJ	Associated value is considered estimated at an elevated detection
UJ1	Estimated at elevated level – Verification
V	No problems with the data – Validation
V1	No problems with the data – Verification
Y	Analytical results in validation process
Z	Validation was not requested or could not be performed

**Table A2.3**  
**V&V Reason Code Definitions**

Validation Reason Code	Description
***	Unknown code from RFEDS
1	Holding times were exceeded
2	Holding times were grossly exceeded
3	Initial calibration correlation coefficient <0.995
4	Calibration verification criteria were not met
5	CRDL check sample recovery criteria were not met
6	Incorrect calibration of instrument
7	Analyte values > IDL were found in the blanks
8	Negative bias was indicated in the blanks
9	Interference indicated in the ICP interference check sample
10	Laboratory control sample recovery criteria were not met
11	Duplicate sample precision criteria were not met
12	Predigestion matrix spike criteria were not met (+/- 25 percent)
13	Predigestion matrix spike criteria were not met (<30 percent)
14	Post-digestion matrix spike recovery criteria were not met
15	MSA was required but not performed
16	MSA calibration correlation coefficient <0.995
17	Serial dilution criteria not met
18	Documentation was not provided
19	Calibration verification criteria not met
20	AA duplicate injection precision criteria were not met
21	Reagent blanks exceeded MDA
22	Tracer contamination
h	Improper aliquot size
24	Sample aliquot not taken quantitatively
25	Primary standard had exceeded expiration date
26	No raw data submitted by the laboratory
27	Recovery criteria were not met
28	Duplicate analysis was not performed
29	Verification criteria were not met
30	Replicate precision criteria were not met
31	Replicate analysis was not performed
32	Laboratory control samples >+/- 3 sigma
33	Laboratory control samples >+/- 2 sigma and <+/- 3 sigma
35	Transformed spectral index external ST criteria were not met
36	MDA exceeded the RDL
37	Sample exceeded efficiency curve weight limit
38	Excessive solids on planchet
39	Tune criteria not met
40	Organics initial calibration criteria were not met

**Table A2.3**  
**V&V Reason Code Definitions**

<b>Validation Reason Code</b>	<b>Description</b>
41	Organics continuing calibration criteria were not met
42	Surrogates were outside criteria
43	Internal standards outside criteria
44	No mass spectra were provided
45	Results were not confirmed
47	Percent breakdown exceeded 20 percent
48	Linear range of instrument was exceeded
49	Method blank contamination
51	Nonverifiable laboratory results and/or unsubmitted data
52	Transcription error
53	Calculation error
54	Incorrect reported activity or MDA
55	Result exceeds linear range; serial dilution value reported
56	IDL changed due to significant figure discrepancy
57	Percent solids < 30 percent
58	Percent solids < 10 percent
59	Blank activity exceeded RDL
60	Blank recovery criteria were not met
61	Replicate recovery criteria were not met
62	LCS relative percent error criteria not met
63	LCS expected value not submitted/verifiable
64	Nontraceable/noncertified standard was used
67	Sample results not submitted/verifiable
68	Frequency of quality control samples not met
69	Samples not distilled
70	Resolution criteria not met
71	Unit conversion of results
72	Calibration counting statistics not met
73	Daily instrument performance assessment not performed
74	LCS data not submitted
75	Blank data not submitted
76	Instrument gain and/or efficiency not submitted
77	Detector efficiency criteria not met
78	MDAs were calculated by reviewer
79	Result obtained through dilution
80	Spurious counts of unknown origin
81	Repeat count outside of 3 sigma counting error
82	Sample results were not corrected for decay
83	Sample results were not included on Data Summary Table
84	Key fields wrong

**Table A2.3**  
**V&V Reason Code Definitions**

<b>Validation Reason Code</b>	<b>Description</b>
85	Record added by QLI
86	Results considered qualitative not quantitative
87	Laboratory did no analysis for this record
88	Blank corrected results
89	Sample analysis was not requested
90	Sample result was not validated due to reanalysis
91	Unit conversion; QC sample activity/uncertainty/MDA
99	See hard copy for further explanation
101	Holding times were exceeded (attributed to laboratory problem)
102	Holding times were grossly exceeded (attribute to laboratory problem)
103	Calibration correlation coefficient does not meet requirement
104	Calibration verification recovery criteria were not met
105	Low-level check sample recovery criteria were not met
106	Calibration did not contain minimum number of standards
107	Analyte detected but < RDL in calibration blank verification
109	Interference indicated in the ICP interference check sample
110	Laboratory control sample recovery criteria were not met
111	Laboratory duplicate sample precision criteria were not met
112	Predigestion matrix spike criteria were not met (+/- 25 percent)
113	Predigestion matrix spike recovery is <30 percent
114	Post-digestion matrix spike criteria were not met
115	MSA was required but not performed
116	MSA calibration correlation coefficient <0.995
117	Serial dilution percent D criteria not met
123	Improper aliquot size
128	Laboratory duplicate was not analyzed
129	Verification criteria for frequency or sequence were not met
130	Replicate precision criteria were not met
131	Confirmation percent difference criteria not met
132	Laboratory control samples >+/- 3 sigma
136	MDA exceeded the RDL
139	Tune criteria not met
140	Requirements for independent calibration verification were not met
141	Continuing calibration verification criteria were not met
142	Surrogates were outside criteria
143	Internal standards outside criteria
145	Results were not confirmed
147	Percent breakdown exceeded 20 percent
148	Linear range of measurement system was exceeded
149	Method, preparation, or reagent blank contamination > RDL

**Table A2.3**  
**V&V Reason Code Definitions**

<b>Validation Reason Code</b>	<b>Description</b>
150	Unknown carrier volume
152	Reported data do not agree with raw data
153	Calculation error
155	Original result exceeds linear range; serial dilution value reported
159	Magnitude of calibration verification blank result exceeded the RDL
164	Standard traceability or certification requirements not met
166	Carrier aliquot nonverifiable
168	QC sample frequency does not meet requirements
170	Resolution criteria not met
172	Calibration counting statistics not met
174	LCS data not submitted
175	Blank data not submitted
177	Detector efficiency criteria not met
188	Blank corrected results
199	See hard copy for further explanation
201	Preservation requirements not met by the laboratory
205	Unobtainable omissions or errors on SDP (required for databases)
206	Analyses were not requested according to the SOW
207	Sample pretreatment or sample preparation method is incorrect
211	Poor cleanup recovery
212	Instrument detection limit was not provided
213	Instrument detection limit is > the associated RDL
214	IDL is older than 3 months from date of analysis
215	Blank results were not reported to the IDL/MDL
216	Post-digestion spike recoveries outside of 85-115 percent criteria
217	Post-digestion spike recoveries were < 10 percent
218	Sample COC was not verifiable (attributed to laboratory)
219	Standards have expired or are not valid
220	TCLP sample percent solids < 0.5 percent
222	TCLP particle size was not performed
224	Incomplete TCLP extraction data
225	Insufficient TCLP extraction time
226	TIC misidentification
227	No documentation regarding deviations from methods or SOW
228	Calibration recoveries affecting data quality have not been met
229	Element not analyzed in ICP interference check sample
230	QC sample/analyte (e.g., spike, duplicate, LCS) not analyzed
231	MS/MSD criteria not met
232	Control limits not assigned correctly
233	Sample matrix QC does not represent samples analyzed

**Table A2.3**  
**V&V Reason Code Definitions**

<b>Validation Reason Code</b>	<b>Description</b>
234	QC sample does not meet method requirement
235	Duplicate sample control limits do not pass
236	LCS control limits do not pass
237	Preparation blank control limits do not pass
238	Blank correction was not performed
239	Winsorized mean plus standard deviation of the same not calculated or calculated wrong
240	Sample preparations for soil/sludge/sediment were not homog/aliqu properly
241	No micro PPT or electroplating data available
242	Tracer requirements were not met
243	Standard values were not calculated correctly (LCS, tracer, standards)
244	Standard or tracer is not NIST traceable
245	Energy calibration criteria not met
246	Background calibration criteria were not met
247	Sample or control analysis not chemically separated from each other
248	Single combined TCLP result was not repeated for sample with both mis+nonm
249	Result qualified due to blank contamination
250	Incorrect analysis sequence
251	Misidentified target compounds
252	Result is suspect DU
701	Holding times were exceeded (not attributed to laboratory)
702	Holding times were grossly exceeded (not attributed to laboratory)
703	Samples were not preserved properly in the field (not attributed to laboratory)
801	Missing deliverables (required for data assessment)
802	Missing deliverables (not required for data assessment)
803	Omissions or errors on SDP deliverables (required for data assessment)
804	Omissions or errors on SDP deliverables (not required for data assessment)
805	Information missing from case narrative
806	Site samples not used for sample matrix QC
807	Original documentation not provided
808	Incorrect or incomplete DRC
809	Non-site samples reported with site samples
810	EDD does not match hard copy; EDD may be resubmitted

**Table A2.4**  
**Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters**

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
188, 88	Blank corrected results	Blanks	Representativeness
238	Blank correction was not performed	Blanks	Representativeness
175, 75	Blank data not submitted	Blanks	Representativeness
60	Blank recovery criteria were not met	Blanks	Representativeness
215	Blank results were not reported to the IDL/MDL	Blanks	Representativeness
107, 159	Calibration verification blank contamination	Blanks	Representativeness
149, 21, 237, 249, 49, 59, 7	Method, preparation, or reagent blank contamination	Blanks	Representativeness
8	Negative bias indicated in the blanks	Blanks	Representativeness
153, 53	Calculation error	Calculation Errors	Other
232	Control limits not assigned correctly	Calculation Errors	Other
246	Background calibration criteria were not met	Calibration	Accuracy
103, 3	Calibration correlation coefficient did not meet requirements	Calibration	Accuracy
172, 72	Calibration counting statistics did not meet criteria	Calibration	Accuracy
106	Calibration did not contain minimum number of standards	Calibration	Accuracy
228	Calibration requirements affecting data quality have not been met	Calibration	Accuracy
104, 141, 19, 29, 4, 40, 41	Continuing calibration verification criteria were not met	Calibration	Accuracy
245	Energy calibration criteria not met	Calibration	Accuracy
6	Incorrect calibration of instrument	Calibration	Accuracy
148, 48	Result exceeded linear range of measurement system	Calibration	Accuracy
155, 55	Original result exceeded linear range, serial dilution value reported	Calibration	Accuracy
140	Requirements for independent calibration verification were not met	Calibration	Accuracy
129	Frequency or sequencing verification criteria not met	Calibration	Accuracy
131	Confirmation percent difference criteria not met	Confirmation	Precision
145, 45	Results were not confirmed	Confirmation	Precision
18	Sufficient documentation not provided by the laboratory	Documentation issues	Representativeness
705	Electronic qualifiers were applied from validation report by hand	Documentation issues	Other
805	Information missing from case narrative	Documentation issues	Other
84	Key data field incorrect	Documentation issues	Other
802	Missing deliverables (not required for validation)	Documentation issues	Other
801	Missing deliverables (required for validation)	Documentation issues	Representativeness
227	No documentation regarding deviations from methods or SOW	Documentation issues	Other
44	No mass spectra were provided	Documentation issues	Representativeness
241	No micro pipette or electroplating data available	Documentation issues	Other
26	No raw data submitted by the laboratory	Documentation issues	Representativeness

**Table A2.4**  
**Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters**

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
804	Omissions or errors in SDP (not required for validation)	Documentation issues	Other
803	Omissions or errors in SDP (required for validation)	Documentation issues	Representativeness
807	Original documentation not provided	Documentation issues	Other
85	Record added by the validator	Documentation issues	Other
152	Reported data do not agree with raw data	Documentation issues	Other
89	Sample analysis was not requested	Documentation issues	Other
218	Sample COC was not verifiable (attributed to laboratory)	Documentation issues	Representativeness
704	Sample COC was not verifiable (not attributed to laboratory)	Documentation issues	Representativeness
83	Sample results were not included on Data Summary Table	Documentation issues	Other
52	Transcription error	Documentation issues	Other
205	Unobtainable omissions or errors on SDP (required for data assessment)	Documentation issues	Representativeness
1, 101, 701	Holding times were exceeded	Holding times	Representativeness
2, 102, 702	Holding times were grossly exceeded	Holding times	Representativeness
251	Misidentified target compounds	Identification errors	Representativeness
70	Resolution criteria not met	Identification errors	Representativeness
226	TIC misidentification	Identification errors	Representativeness
143, 43	Internal standards did not meet criteria	Internal standards	Accuracy
5	CRDL check sample recovery criteria were not met	LCS	Accuracy
33	LCS > $\pm 2$ sigma and < $\pm 3$ sigma	LCS	Accuracy
10, 110, 236	LCS recovery criteria were not met	LCS	Accuracy
132, 32	Laboratory control samples > $\pm 3$ sigma	LCS	Accuracy
174, 74	LCS data not submitted	LCS	Representativeness
63	Expected LCS value not submitted/verifiable	LCS	Representativeness
62	LCS relative percent error criteria not met	LCS	Accuracy
105	Low-level check sample recovery criteria were not met	LCS	Accuracy
230	QC sample/analyte (e.g., spike, duplicate, LCS) not analyzed	LCS	Representativeness
28	Duplicate analysis was not performed	Matrices	Precision
11, 235	Duplicate sample precision criteria were not met	Matrices	Precision
111	LCS/LCSD precision criteria were not met	Matrices	Precision
128	Laboratory duplicate was not analyzed	Matrices	Precision
231	MS/MSD criteria not met	Matrices	Precision
116, 16	MSA calibration correlation coefficient < 0.995	Matrices	Accuracy
115, 15	MSA was required but not performed	Matrices	Representativeness
58	Sample contained < 10 percent solid material	Matrices	Representativeness
57	Sample contained < 30 percent solid material	Matrices	Representativeness
217	Post-digestion spike recoveries were < 10%	Matrices	Accuracy
14, 114, 216	Post-digestion matrix spike criteria were not met	Matrices	Accuracy
113, 13	Predigestion matrix spike recovery is < 30%	Matrices	Accuracy

**Table A2.4**  
**Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters**

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
112, 12	Predigestion matrix spike recovery criteria were not met	Matrices	Accuracy
27	Recovery criteria were not met	Matrices	Accuracy
31	Replicate analysis was not performed	Matrices	Precision
130, 30	Replicate precision criteria were not met	Matrices	Precision
61	Replicate recovery criteria were not met	Matrices	Accuracy
233	Sample matrix QC does not represent samples analyzed	Matrices	Representativeness
117, 17	Serial dilution criteria not met	Matrices	Accuracy
806	Site samples not used for sample matrix QC	Matrices	Representativeness
810	EDD does not match hard copy; EDD may be resubmitted	Other	Other
214	IDL is older than 3 months from date of analysis	Other	Accuracy
250	Incorrect analysis sequence	Other	Representativeness
808	Incorrect or incomplete DRC	Other	Representativeness
212	Instrument detection limit was not provided	Other	Other
87	Laboratory did no analysis for this record	Other	Other
809	Nonsite samples reported with Site samples	Other	Other
64	Nontraceable/noncertified standard was used	Other	Accuracy
51	Nonverifiable laboratory results and/or unsubmitted data	Other	Representativeness
211	Poor cleanup recovery	Other	Accuracy
25	Primary standard had exceeded expiration date	Other	Accuracy
234	QC sample does not meet method requirement	Other	Representativeness
168, 68	QC sample frequency does not meet requirements	Other	Representativeness
252	Result is suspect due to dilution	Other	Other
79	Result obtained through dilution	Other	Other
37	Sample exceeded efficiency curve weight limit	Other	Accuracy
247	Sample or control analyses not chemically separated from each other	Other	Representativeness
90	Sample result was not validated due to re-analysis	Other	Other
67	Sample results not submitted/verifiable	Other	Representativeness
199, 99	See hard copy for further explanation	Other	Other
248	Single combined TCLP results was not reported for sample with both mis+nonm	Other	Accuracy
80	Spurious counts of unknown origin	Other	Representativeness
244	Standard or tracer is not NIST traceable	Other	Accuracy
164	Standard traceability or certification requirements not met	Other	Accuracy
219	Standards have expired or are not valid	Other	Accuracy
243	Standard values were not calculated correctly (LCS, tracer, standards)	Other	Other
22	Tracer contamination	Other	Accuracy
242	Tracer requirements were not met	Other	Accuracy
71	Unit conversion of results	Other	Other

**Table A2.4**  
**Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters**

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
239	Winsorized mean+standard deviation of the same not calculated or calculated wrong	Other	Other
38	Excessive solids on planchet	Sample preparation	Accuracy
123, 23	Improper aliquot size	Sample preparation	Accuracy
224	Incomplete TCLP extraction data	Sample preparation	Representativeness
225	Insufficient TCLP extraction time	Sample preparation	Representativeness
201	Preservation requirements not met by the laboratory	Sample preparation	Representativeness
24	Sample aliquot not taken quantitatively	Sample preparation	Accuracy
240	Sample preparation for soil/sludge/ sediment were not homog/aliqu properly	Sample preparation	Representativeness
207	Sample pretreatment or preparation method is incorrect	Sample preparation	Representativeness
69	Samples not distilled	Sample preparation	Representativeness
703	Samples were not preserved properly in the field	Sample preparation	Representativeness
222	TCLP particle size was not performed	Sample preparation	Representativeness
220	TCLP sample percent solids < 0.5 percent	Sample preparation	Representativeness
56	IDL changed due to significant figure discrepancy	Sensitivity	Representativeness
54	Incorrect reported activity or MDA	Sensitivity	Other
213	Instrument detection limit > the associated RDL	Sensitivity	Representativeness
136, 36	MDA exceeded the RDL	Sensitivity	Representativeness
78	MDA was calculated by reviewer	Sensitivity	Other
81	Repeat count outside of 3 sigma counting error	Sensitivity	Precision
86	Results considered qualitative not quantitative	Sensitivity	Accuracy
82	Sample results were not corrected for decay	Sensitivity	Other
91	Unit conversion, QC sample activity uncertainty/MDA	Sensitivity	Representativeness
142, 42	Surrogates were outside criteria	Surrogate	Accuracy
20	AA duplicate injection precision criteria were not met	Instrument Set-up	Precision
73	Daily instrument performance assessment not performed	Instrument Set-up	Accuracy
177, 77	Detector efficiency criteria not met	Instrument Set-up	Accuracy
229	Element not analyzed in ICP interference check sample	Instrument Set-up	Representativeness
76	Instrument gain and/or efficiency not submitted	Instrument Set-up	Representativeness
109, 9	Interference indicated in the ICP interference check sample	Instrument Set-up	Accuracy
147, 47	Percent breakdown exceeded 20 percent	Instrument Set-up	Representativeness
170	Resolution criteria not met	Instrument Set-up	Representativeness
35	Transformed spectral index external site criteria were not met	Instrument Set-up	Representativeness
139, 39	Tune criteria not met	Instrument Set-up	Accuracy
206	Analysis was not requested according to SOW	Unknown	Other
166	Carrier aliquot nonverifiable	Unknown	Representativeness
150	Unknown carrier volume	Unknown	Representativeness

Table A2.5  
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Dioxins and Furans	WATER	Documentation Issues	Transcription error	No	1	3	33.3
Herbicide	WATER	Documentation Issues	Transcription error	No	4	11	36.4
Metal	SOIL	Blanks	Calibration verification blank contamination	No	65	1,397	4.65
Metal	SOIL	Blanks	Calibration verification blank contamination	Yes	5	1,397	0.358
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	28	1,397	2.00
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	7	1,397	0.501
Metal	SOIL	Blanks	Negative bias indicated in the blanks	No	2	1,397	0.143
Metal	SOIL	Blanks	Negative bias indicated in the blanks	Yes	3	1,397	0.215
Metal	SOIL	Calibration	Continuing calibration verification criteria were not met	No	2	1,397	0.143
Metal	SOIL	Documentation Issues	Transcription error	No	1	1,397	0.0716
Metal	SOIL	Documentation Issues	Transcription error	Yes	10	1,397	0.716
Metal	SOIL	Holding Times	Holding times were exceeded	No	1	1,397	0.0716
Metal	SOIL	Instrument Set-up	Interference was indicated in the interference check sample	Yes	5	1,397	0.358
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	No	13	1,397	0.931
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	Yes	8	1,397	0.573
Metal	SOIL	LCS	LCS recovery criteria were not met	No	27	1,397	1.93
Metal	SOIL	LCS	LCS recovery criteria were not met	Yes	55	1,397	3.94
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	No	8	1,397	0.573
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	Yes	19	1,397	1.36
Metal	SOIL	Matrices	Duplicate sample precision criteria were not met	Yes	4	1,397	0.286
Metal	SOIL	Matrices	LCS/LCSD precision criteria were not met	Yes	32	1,397	2.29
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	No	4	1,397	0.286
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	Yes	6	1,397	0.429
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	No	44	1,397	3.15
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	Yes	109	1,397	7.80
Metal	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	2	1,397	0.143
Metal	SOIL	Matrices	Serial dilution criteria were not met	Yes	98	1,397	7.02
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	No	37	1,397	2.65
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	87	1,397	6.23
Metal	SOIL	Other	Result obtained through dilution	No	1	1,397	0.0716
Metal	SOIL	Other	Result obtained through dilution	Yes	4	1,397	0.286

119

Table A2.5  
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	SOIL	Sensitivity	IDL changed due to a significant figure discrepancy	No	2	1,397	0.143
Metal	WATER	Blanks	Calibration verification blank contamination	No	119	3,967	3.00
Metal	WATER	Blanks	Calibration verification blank contamination	Yes	33	3,967	0.832
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	No	173	3,967	4.36
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	42	3,967	1.06
Metal	WATER	Blanks	Negative bias indicated in the blanks	No	24	3,967	0.605
Metal	WATER	Blanks	Negative bias indicated in the blanks	Yes	21	3,967	0.529
Metal	WATER	Calculation Errors	Control limits not assigned correctly	No	1	3,967	0.0252
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	No	5	3,967	0.126
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	1	3,967	0.0252
Metal	WATER	Calibration	Continuing calibration verification criteria were not met	No	5	3,967	0.126
Metal	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	6	3,967	0.151
Metal	WATER	Documentation Issues	Electronic qualifiers were applied from validation report by hand	No	18	3,967	0.454
Metal	WATER	Documentation Issues	Electronic qualifiers were applied from validation report by hand	Yes	11	3,967	0.277
Metal	WATER	Documentation Issues	Key data fields incorrect	No	16	3,967	0.403
Metal	WATER	Documentation Issues	Key data fields incorrect	Yes	22	3,967	0.555
Metal	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	21	3,967	0.529
Metal	WATER	Documentation Issues	Missing deliverables (not required for validation)	Yes	35	3,967	0.882
Metal	WATER	Documentation Issues	Missing deliverables (required for validation)	No	10	3,967	0.252
Metal	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	17	3,967	0.429
Metal	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	62	3,967	1.56
Metal	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	113	3,967	2.85
Metal	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	2	3,967	0.0504
Metal	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	2	3,967	0.0504
Metal	WATER	Documentation Issues	Record added by the validator	No	48	3,967	1.21
Metal	WATER	Documentation Issues	Record added by the validator	Yes	53	3,967	1.34
Metal	WATER	Documentation Issues	Transcription error	No	126	3,967	3.18
Metal	WATER	Documentation Issues	Transcription error	Yes	21	3,967	0.529
Metal	WATER	Holding Times	Holding times were exceeded	No	6	3,967	0.151
Metal	WATER	Holding Times	Holding times were exceeded	Yes	1	3,967	0.0252
Metal	WATER	Holding Times	Holding times were grossly exceeded	Yes	1	3,967	0.0252
Metal	WATER	Instrument Set-up	Interference was indicated in the interference check sample	No	3	3,967	0.0756

Table A2.5  
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	WATER	Instrument Set-up	Interference was indicated in the interference check sample	Yes	11	3,967	0.277
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	No	25	3,967	0.630
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	Yes	15	3,967	0.378
Metal	WATER	LCS	LCS data not submitted by the laboratory	No	1	3,967	0.0252
Metal	WATER	LCS	LCS recovery criteria were not met	No	1	3,967	0.0252
Metal	WATER	LCS	LCS recovery criteria were not met	Yes	14	3,967	0.353
Metal	WATER	LCS	Low level check sample recovery criteria were not met	No	28	3,967	0.706
Metal	WATER	LCS	Low level check sample recovery criteria were not met	Yes	20	3,967	0.504
Metal	WATER	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	No	10	3,967	0.252
Metal	WATER	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	Yes	17	3,967	0.429
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	No	10	3,967	0.252
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	38	3,967	0.958
Metal	WATER	Matrices	LCS/LCSD precision criteria were not met	No	3	3,967	0.0756
Metal	WATER	Matrices	LCS/LCSD precision criteria were not met	Yes	7	3,967	0.176
Metal	WATER	Matrices	MSA calibration correlation coefficient < 0.995	No	1	3,967	0.0252
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	No	45	3,967	1.13
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	Yes	4	3,967	0.101
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	No	44	3,967	1.11
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	66	3,967	1.66
Metal	WATER	Matrices	Recovery criteria were not met	Yes	1	3,967	0.0252
Metal	WATER	Matrices	Serial dilution criteria were not met	No	1	3,967	0.0252
Metal	WATER	Matrices	Serial dilution criteria were not met	Yes	51	3,967	1.29
Metal	WATER	Other	IDL is older than 3 months from date of analysis	No	17	3,967	0.429
Metal	WATER	Other	IDL is older than 3 months from date of analysis	Yes	31	3,967	0.781
Metal	WATER	Sample Preparation	Samples were not properly preserved in the field	No	8	3,967	0.202
Metal	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	23	3,967	0.580
Metal	WATER	Sensitivity	IDL changed due to a significant figure discrepancy	No	7	3,967	0.176
PCB	SOIL	Surrogates	Surrogate recovery criteria were not met	No	7	84	8.33
PCB	WATER	Documentation Issues	Key data fields incorrect	No	7	28	25
PCB	WATER	Surrogates	Surrogate recovery criteria were not met	No	7	28	25
Pesticide	SOIL	Surrogates	Surrogate recovery criteria were not met	No	20	251	7.97
Pesticide	WATER	Calibration	Continuing calibration verification criteria were not met	No	3	92	3.26

Table A2.5  
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Pesticide	WATER	Documentation Issues	Key data fields incorrect	No	20	92	21.7
Pesticide	WATER	Documentation Issues	Transcription error	No	4	92	4.35
Pesticide	WATER	Internal Standards	Internal standards did not meet criteria	No	1	92	1.09
Pesticide	WATER	Surrogates	Surrogate recovery criteria were not met	No	21	92	22.8
Radionuclide	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	11	390	2.82
Radionuclide	SOIL	Calculation Errors	Calculation error	Yes	2	390	0.513
Radionuclide	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	12	390	3.08
Radionuclide	SOIL	Documentation Issues	Record added by the validator	Yes	1	390	0.256
Radionuclide	SOIL	Documentation Issues	Results were not included on Data Summary Table	No	4	390	1.03
Radionuclide	SOIL	Documentation Issues	Results were not included on Data Summary Table	Yes	2	390	0.513
Radionuclide	SOIL	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	44	390	11.3
Radionuclide	SOIL	Documentation Issues	Transcription error	No	4	390	1.03
Radionuclide	SOIL	Documentation Issues	Transcription error	Yes	22	390	5.64
Radionuclide	SOIL	Instrument Set-up	Detector efficiency did not meet requirements	Yes	4	390	1.03
Radionuclide	SOIL	LCS	LCS recovery > +/- 3 sigma	Yes	13	390	3.33
Radionuclide	SOIL	LCS	LCS recovery criteria were not met	Yes	1	390	0.256
Radionuclide	SOIL	Matrices	Recovery criteria were not met	No	1	390	0.256
Radionuclide	SOIL	Matrices	Replicate precision criteria were not met	Yes	7	390	1.79
Radionuclide	SOIL	Matrices	Replicate recovery criteria were not met	Yes	1	390	0.256
Radionuclide	SOIL	Other	Lab results not verified due to unsubmitted data	No	2	390	0.513
Radionuclide	SOIL	Other	QC sample does not meet method requirements	No	17	390	4.36
Radionuclide	SOIL	Other	QC sample does not meet method requirements	Yes	13	390	3.33
Radionuclide	SOIL	Other	See hard copy for further explanation	Yes	4	390	1.03
Radionuclide	SOIL	Sensitivity	Incorrect reported activity or MDA	No	5	390	1.28
Radionuclide	SOIL	Sensitivity	Incorrect reported activity or MDA	Yes	1	390	0.256
Radionuclide	SOIL	Sensitivity	MDA exceeded the RDL	Yes	5	390	1.28
Radionuclide	SOIL	Sensitivity	MDA was calculated by reviewer	No	3	390	0.769
Radionuclide	SOIL	Sensitivity	MDA was calculated by reviewer	Yes	63	390	16.2
Radionuclide	SOIL	Sensitivity	Results considered qualitative not quantitative	No	1	390	0.256
Radionuclide	WATER	Blanks	Blank correction was not performed	No	5	1,973	0.253
Radionuclide	WATER	Blanks	Blank correction was not performed	Yes	3	1,973	0.152
Radionuclide	WATER	Blanks	Blank recovery criteria were not met	No	5	1,973	0.253

**Table A2.5**  
**Summary of V&V Observations**

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	WATER	Blanks	Blank recovery criteria were not met	Yes	6	1,973	0.304
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	No	20	1,973	1.01
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	55	1,973	2.79
Radionuclide	WATER	Calculation Errors	Calculation error	No	14	1,973	0.710
Radionuclide	WATER	Calculation Errors	Calculation error	Yes	2	1,973	0.101
Radionuclide	WATER	Calibration	Calibration requirements affecting data quality have not been met	No	1	1,973	0.0507
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	No	11	1,973	0.558
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	70	1,973	3.55
Radionuclide	WATER	Documentation Issues	Information missing from case narrative	No	7	1,973	0.355
Radionuclide	WATER	Documentation Issues	Information missing from case narrative	Yes	2	1,973	0.101
Radionuclide	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	6	1,973	0.304
Radionuclide	WATER	Documentation Issues	Missing deliverables (not required for validation)	Yes	4	1,973	0.203
Radionuclide	WATER	Documentation Issues	Missing deliverables (required for validation)	No	15	1,973	0.760
Radionuclide	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	7	1,973	0.355
Radionuclide	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	44	1,973	2.23
Radionuclide	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	15	1,973	0.760
Radionuclide	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	2	1,973	0.101
Radionuclide	WATER	Documentation Issues	Record added by the validator	Yes	2	1,973	0.101
Radionuclide	WATER	Documentation Issues	Sufficient documentation not provided by the laboratory	No	1	1,973	0.0507
Radionuclide	WATER	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	27	1,973	1.37
Radionuclide	WATER	Documentation Issues	Transcription error	No	38	1,973	1.93
Radionuclide	WATER	Documentation Issues	Transcription error	Yes	21	1,973	1.06
Radionuclide	WATER	Holding Times	Holding times were exceeded	Yes	4	1,973	0.203
Radionuclide	WATER	Holding Times	Holding times were grossly exceeded	No	10	1,973	0.507
Radionuclide	WATER	Holding Times	Holding times were grossly exceeded	Yes	9	1,973	0.456
Radionuclide	WATER	Instrument Set-up	Resolution criteria were not met	Yes	9	1,973	0.456
Radionuclide	WATER	Instrument Set-up	Transformed spectral index external site criteria were not met	No	2	1,973	0.101
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	Yes	5	1,973	0.253
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	No	26	1,973	1.32
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	Yes	32	1,973	1.62
Radionuclide	WATER	LCS	LCS recovery criteria were not met	No	5	1,973	0.253
Radionuclide	WATER	LCS	LCS recovery criteria were not met	Yes	3	1,973	0.152

123

**Table A2.5**  
**Summary of V&V Observations**

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	No	15	1,973	0.760
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	Yes	39	1,973	1.98
Radionuclide	WATER	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	No	1	1,973	0.0507
Radionuclide	WATER	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	Yes	1	1,973	0.0507
Radionuclide	WATER	Matrices	Duplicate analysis was not performed	No	1	1,973	0.0507
Radionuclide	WATER	Matrices	Duplicate analysis was not performed	Yes	2	1,973	0.101
Radionuclide	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	4	1,973	0.203
Radionuclide	WATER	Matrices	Laboratory duplicate was not analyzed	No	1	1,973	0.0507
Radionuclide	WATER	Matrices	Recovery criteria were not met	No	3	1,973	0.152
Radionuclide	WATER	Matrices	Recovery criteria were not met	Yes	13	1,973	0.659
Radionuclide	WATER	Matrices	Replicate analysis was not performed	Yes	4	1,973	0.203
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	No	6	1,973	0.304
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	Yes	33	1,973	1.67
Radionuclide	WATER	Matrices	Replicate recovery criteria were not met	Yes	1	1,973	0.0507
Radionuclide	WATER	Other	QC sample does not meet method requirements	No	18	1,973	0.912
Radionuclide	WATER	Other	QC sample does not meet method requirements	Yes	10	1,973	0.507
Radionuclide	WATER	Other	Sample or control analyses not chemically separated	No	1	1,973	0.0507
Radionuclide	WATER	Other	Sample or control analyses not chemically separated	Yes	2	1,973	0.101
Radionuclide	WATER	Other	See hard copy for further explanation	No	11	1,973	0.558
Radionuclide	WATER	Other	See hard copy for further explanation	Yes	19	1,973	0.963
Radionuclide	WATER	Other	Tracer requirements were not met	No	8	1,973	0.405
Radionuclide	WATER	Other	Tracer requirements were not met	Yes	5	1,973	0.253
Radionuclide	WATER	Sample Preparation	Samples were not properly preserved in the field	No	19	1,973	0.963
Radionuclide	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	9	1,973	0.456
Radionuclide	WATER	Sensitivity	Incorrect reported activity or MDA	No	3	1,973	0.152
Radionuclide	WATER	Sensitivity	Incorrect reported activity or MDA	Yes	2	1,973	0.101
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	No	4	1,973	0.203
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	Yes	13	1,973	0.659
Radionuclide	WATER	Sensitivity	MDA was calculated by reviewer	No	3	1,973	0.152
Radionuclide	WATER	Sensitivity	MDA was calculated by reviewer	Yes	86	1,973	4.36
SVOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	1	751	0.133
SVOC	SOIL	Calibration	Continuing calibration verification criteria were not met	No	8	751	1.07

124

**Table A2.5**  
**Summary of V&V Observations**

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
SVOC	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	1	751	0.133
SVOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	12	751	1.60
SVOC	SOIL	Internal Standards	Internal standards did not meet criteria	Yes	1	751	0.133
SVOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	2	747	0.268
SVOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	12	747	1.61
SVOC	WATER	Calibration	Independent calibration verification criteria not met	No	1	747	0.134
SVOC	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	3	747	0.402
SVOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	11	747	1.47
SVOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	1	747	0.134
SVOC	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	3	747	0.402
SVOC	WATER	Documentation Issues	Transcription error	No	236	747	31.6
SVOC	WATER	Holding Times	Holding times were exceeded	No	12	747	1.61
SVOC	WATER	Holding Times	Holding times were exceeded	Yes	1	747	0.134
SVOC	WATER	Instrument Set-up	Instrument tune criteria were not met	No	6	747	0.803
SVOC	WATER	Internal Standards	Internal standards did not meet criteria	No	23	747	3.08
SVOC	WATER	LCS	LCS recovery criteria were not met	No	4	747	0.535
SVOC	WATER	Sample Preparation	Samples were not properly preserved in the field	No	2	747	0.268
SVOC	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	1	747	0.134
VOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	13	1,490	0.872
VOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	26	1,490	1.74
VOC	SOIL	Calibration	Continuing calibration verification criteria were not met	No	56	1,490	3.76
VOC	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	5	1,490	0.336
VOC	SOIL	Holding Times	Holding times were exceeded	No	34	1,490	2.28
VOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	16	1,490	1.07
VOC	SOIL	Internal Standards	Internal standards did not meet criteria	Yes	2	1,490	0.134
VOC	SOIL	Surrogates	Surrogate recovery criteria were not met	No	33	1,490	2.21
VOC	SOIL	Surrogates	Surrogate recovery criteria were not met	Yes	1	1,490	0.0671
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	8	2,940	0.272
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	4	2,940	0.136
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	22	2,940	0.748
VOC	WATER	Calibration	Independent calibration verification criteria not met	Yes	1	2,940	0.0340
VOC	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	55	2,940	1.87

Table A2.5  
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
VOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	217	2,940	7.38
VOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	1	2,940	0.0340
VOC	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	54	2,940	1.84
VOC	WATER	Documentation Issues	Sample analysis was not requested	Yes	1	2,940	0.0340
VOC	WATER	Documentation Issues	Transcription error	No	19	2,940	0.646
VOC	WATER	Holding Times	Holding times were exceeded	No	178	2,940	6.05
VOC	WATER	Holding Times	Holding times were exceeded	Yes	1	2,940	0.0340
VOC	WATER	Instrument Set-up	Instrument tune criteria were not met	No	109	2,940	3.71
VOC	WATER	Instrument Set-up	Instrument tune criteria were not met	Yes	1	2,940	0.0340
VOC	WATER	Internal Standards	Internal standards did not meet criteria	No	25	2,940	0.850
VOC	WATER	LCS	LCS recovery criteria were not met	No	22	2,940	0.748
VOC	WATER	LCS	LCS recovery criteria were not met	Yes	2	2,940	0.0680
VOC	WATER	Sample Preparation	Samples were not properly preserved in the field	No	55	2,940	1.87
Wet Chemistry	SOIL	Documentation Issues	Transcription error	No	5	35	14.3
Wet Chemistry	SOIL	Holding Times	Holding times were exceeded	Yes	1	35	2.86
Wet Chemistry	SOIL	Matrices	LCS/LCSD precision criteria were not met	Yes	8	35	22.9
Wet Chemistry	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	18	35	51.4
Wet Chemistry	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	6	35	17.1
Wet Chemistry	SOIL	Sample Preparation	Samples were not properly preserved in the field	Yes	1	35	2.86
Wet Chemistry	WATER	Blanks	Calibration verification blank contamination	No	3	990	0.303
Wet Chemistry	WATER	Blanks	Method, preparation, or reagent blank contamination	No	1	990	0.101
Wet Chemistry	WATER	Blanks	Negative bias indicated in the blanks	No	1	990	0.101
Wet Chemistry	WATER	Calculation Errors	Control limits not assigned correctly	Yes	2	990	0.202
Wet Chemistry	WATER	Documentation Issues	Key data fields incorrect	Yes	1	990	0.101
Wet Chemistry	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	1	990	0.101
Wet Chemistry	WATER	Documentation Issues	Missing deliverables (not required for validation)	Yes	2	990	0.202
Wet Chemistry	WATER	Documentation Issues	Missing deliverables (required for validation)	No	1	990	0.101
Wet Chemistry	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	2	990	0.202
Wet Chemistry	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	12	990	1.21
Wet Chemistry	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	27	990	2.73
Wet Chemistry	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	4	990	0.404
Wet Chemistry	WATER	Documentation Issues	Record added by the validator	No	1	990	0.101

Table A2.5  
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Wet Chemistry	WATER	Documentation Issues	Transcription error	No	4	990	0.404
Wet Chemistry	WATER	Documentation Issues	Transcription error	Yes	8	990	0.808
Wet Chemistry	WATER	Holding Times	Holding times were exceeded	No	3	990	0.303
Wet Chemistry	WATER	Holding Times	Holding times were exceeded	Yes	7	990	0.707
Wet Chemistry	WATER	Holding Times	Holding times were grossly exceeded	No	1	990	0.101
Wet Chemistry	WATER	Holding Times	Holding times were grossly exceeded	Yes	1	990	0.101
Wet Chemistry	WATER	Matrices	Predigestion MS recovery criteria were not met	No	6	990	0.606
Wet Chemistry	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	17	990	1.72
Wet Chemistry	WATER	Matrices	Predigestion MS recovery was < 30 percent	Yes	1	990	0.101
Wet Chemistry	WATER	Other	Lab results not verified due to unsubmitted data	Yes	2	990	0.202
Wet Chemistry	WATER	Sample Preparation	Preservation requirements were not met by the laboratory	No	1	990	0.101
Wet Chemistry	WATER	Sample Preparation	Preservation requirements were not met by the laboratory	Yes	8	990	0.808
Wet Chemistry	WATER	Sample Preparation	Sample pretreatment or preparation method was incorrect	Yes	1	990	0.101
Wet Chemistry	WATER	Sample Preparation	Samples were not properly preserved in the field	No	4	990	0.404
Wet Chemistry	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	40	990	4.04

**Table A2.6**  
**Summary of Data Rejected During V&V**

Analyte Group	Matrix	Total No. of Rejected Records	Total No. of Records	Percent Rejected (%)
Dioxins and Furans	WATER	2	13	15.4
Herbicide	SOIL	0	13	0
Herbicide	WATER	6	23	26.1
Metal	SOIL	10	1,436	0.696
Metal	WATER	75	4,976	1.51
PCB	SOIL	0	91	0
PCB	WATER	0	63	0
Pesticide	SOIL	1	273	0.366
Pesticide	WATER	0	203	0
Radionuclide	SOIL	35	445	7.87
Radionuclide	WATER	135	2,489	5.42
SVOC	SOIL	4	815	0.491
SVOC	WATER	83	1,431	5.80
VOC	SOIL	14	1,674	0.836
VOC	WATER	99	3,899	2.54
Wet Chemistry	SOIL	0	35	0
Wet Chemistry	WATER	16	1,117	1.43
	<b>Total</b>	<b>480</b>	<b>18,996</b>	<b>0.0253</b>

**Table A2.7**  
**Summary of RPDs/DERs of Field Duplicate Analyte Pairs**

Analyte Group	Matrix	No. of Duplicates Failing RPD/DER Criteria	Total No. of Duplicate Pairs	Percent Failure (%)	Field Duplicate Frequency (%)
Metal	SOIL	16	141	11.3	10.1
Metal	WATER	1	93	1.08	2.05
Radionuclide	SOIL	0	30	0	6.64
Radionuclide	WATER	0	93	0	2.35
VOC	SOIL	2	72	2.78	4.62
Wet Chemistry	SOIL	0	1	0	2.86
Wet Chemistry	WATER	0	17	0	1.07

128

**Table A2.8**  
**Summary of Data Estimated or Undetected Due to V&V Determinations**

Analyte Group	Matrix	No. of CRA Data Records Qualified	Total No. of V&V CRA Records	Detect?	Percent Qualified (%)
Metal	SOIL	174	1,397	No	12.5
Metal	SOIL	332	1,397	Yes	23.8
Metal	WATER	460	3,967	No	11.6
Metal	WATER	301	3,967	Yes	7.59
PCB	SOIL	7	84	No	8.33
PCB	WATER	7	28	No	25
Pesticide	SOIL	20	251	No	7.97
Pesticide	WATER	23	92	No	25
Radionuclide	SOIL	3	390	No	0.769
Radionuclide	SOIL	4	390	Yes	1.03
Radionuclide	WATER	16	1,973	No	0.811
Radionuclide	WATER	30	1,973	Yes	1.52
SVOC	SOIL	21	751	No	2.80
SVOC	WATER	51	747	No	6.83
SVOC	WATER	1	747	Yes	0.134
VOC	SOIL	142	1,490	No	9.53
VOC	SOIL	29	1,490	Yes	1.95
VOC	WATER	247	2,940	No	8.40
VOC	WATER	5	2,940	Yes	0.170
Wet Chemistry	SOIL	19	35	Yes	54.3
Wet Chemistry	WATER	13	990	No	1.31
Wet Chemistry	WATER	32	990	Yes	3.23
	<b>Total</b>	<b>1,937</b>	<b>15,161</b>		<b>0.128</b>

**Table A2.9**  
**Summary of Data Qualified as Undetected Due to Blank Contamination**

Analyte Group	Matrix	No. of CRA Records Qualified as Undetected	Total No. of CRA Records with Detected Results	Percent Qualified as Undetected
Metal	SOIL	52	1,072	4.85
Metal	WATER	72	2,025	3.56
Wet Chemistry	WATER	1	770	0.13
	<b>Total</b>	<b>125</b>	<b>3,867</b>	<b>3.23%</b>

<sup>a</sup> As determined by the laboratory prior to V&V.

**COMPREHENSIVE RISK ASSESSMENT**

**LOWER WALNUT DRAINAGE EXPOSURE UNIT**

**VOLUME 8: ATTACHMENT 3**

**Statistical Analyses and Professional Judgment**

## Table of Contents

<b>ACRONYMS AND ABBREVIATIONS.....</b>	<b>viii</b>
<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE LOWER WALNUT DRAINAGE EXPOSURE UNIT .....</b>	<b>1</b>
2.1 Surface Soil/Surface Sediment Data Used in the HHRA .....	2
2.2 Subsurface Soil/Subsurface Sediment Data Used in the HHRA .....	2
2.3 Surface Soil Data Used in the ERA (Non-PMJM Receptors) .....	3
2.4 Surface Soil Data Used in the ERA (PMJM Receptors).....	4
2.5 Subsurface Soil Data used in the ERA .....	5
<b>3.0 UPPER-BOUND EXPOSURE POINT CONCENTRATION COMPARISON TO LIMITING ECOLOGICAL SCREENING LEVELS.....</b>	<b>5</b>
3.1 ECOIs in Surface Soil (Non-PMJM) .....	5
3.2 ECOIs in Surface Soil (PMJM) .....	6
3.3 ECOIs in Subsurface Soil .....	6
<b>4.0 PROFESSIONAL JUDGMENT.....</b>	<b>6</b>
4.1 Aluminum .....	7
4.1.1 Summary of Process Knowledge .....	8
4.1.2 Evaluation of Spatial Trends.....	8
4.1.3 Pattern Recognition.....	8
4.1.4 Comparison to RFETS Background and Other Background Data Sets.....	8
4.1.5 Risk Potential for Plants and Wildlife .....	9
4.1.6 Conclusion .....	9
4.2 Antimony .....	9
4.2.1 Summary of Process Knowledge .....	9
4.2.2 Evaluation of Spatial Trends.....	9
4.2.3 Pattern Recognition.....	10
4.2.4 Comparison to RFETS Background and Other Background Data Sets.....	10
4.2.5 Risk Potential for Plants and Wildlife .....	10
4.2.6 Conclusion .....	11
4.3 Arsenic .....	11
4.3.1 Summary of Process Knowledge .....	11
4.3.2 Evaluation of Spatial Trends.....	11
4.3.3 Pattern Recognition.....	11
4.3.4 Comparison to RFETS Background and Other Background Data Sets.....	12
4.3.5 Risk Potential for HHRA .....	12
4.3.6 Conclusion .....	12
4.4 Boron.....	12
4.4.1 Summary of Process Knowledge .....	13
4.4.2 Evaluation of Spatial Trends.....	13
4.4.3 Pattern Recognition.....	13

4.4.4	Comparison to RFETS Background and Other Background Data Sets.....	13
4.4.5	Risk Potential for Plants and Wildlife .....	13
4.4.6	Conclusion .....	14
4.5	Chromium .....	14
4.5.1	Summary of Process Knowledge .....	14
4.5.2	Evaluation of Spatial Trends.....	15
4.5.3	Pattern Recognition.....	15
4.5.4	Comparison to RFETS Background and Other Background Data Sets.....	15
4.5.5	Risk Potential for Plants and Wildlife .....	16
4.5.6	Conclusion .....	16
4.6	4,4'-DDT.....	16
4.6.1	Summary of Process Knowledge .....	17
4.6.2	Summary of Spatial Trends .....	17
4.6.3	Conclusion .....	17
4.7	Lithium.....	17
4.7.1	Summary of Process Knowledge .....	17
4.7.2	Evaluation of Spatial Trends.....	18
4.7.3	Pattern Recognition.....	18
4.7.4	Comparison to RFETS Background and Other Background Data Sets.....	18
4.7.5	Risk Potential for Plants and Wildlife .....	18
4.7.6	Conclusion .....	19
4.8	Molybdenum.....	19
4.8.1	Summary of Process Knowledge .....	19
4.8.2	Evaluation of Spatial Trends.....	19
4.8.3	Pattern Recognition.....	19
4.8.4	Comparison to RFETS Background and Other Background Data Sets.....	20
4.8.5	Risk Potential for Plants and Wildlife .....	20
4.8.6	Conclusion .....	20
4.9	Nickel.....	20
4.9.1	Summary of Process Knowledge .....	21
4.9.2	Evaluation of Spatial Trends.....	21
4.9.3	Pattern Recognition.....	21
4.9.4	Comparison to RFETS Background and Other Background Data Sets.....	21
4.9.5	Risk Potential for Plants and Wildlife .....	22
4.9.6	Conclusion .....	22
4.10	Radium-228.....	22
4.10.1	Summary of Process Knowledge .....	23
4.10.2	Evaluation of Spatial Trends.....	23
4.10.3	Pattern Recognition.....	23
4.10.4	Comparison to RFETS Background and Other Background Data Sets.....	23

	4.10.5 Risk Potential for HHRA .....	23
	4.10.6 Conclusion .....	24
4.11	Selenium .....	24
	4.11.1 Summary of Process Knowledge .....	24
	4.11.2 Evaluation of Spatial Trends.....	24
	4.11.3 Pattern Recognition.....	24
	4.11.4 Comparison to RFETS Background and Other Background Data Sets.....	25
	4.11.5 Risk Potential for Plants and Wildlife .....	25
	4.11.6 Conclusion .....	25
4.12	Tin.....	26
	4.12.1 Summary of Process Knowledge .....	26
	4.12.2 Evaluation of Spatial Trends.....	26
	4.12.3 Pattern Recognition.....	26
	4.12.4 Comparison to RFETS Background and Other Background Data Sets.....	26
	4.12.5 Risk Potential for Plants and Wildlife .....	27
	4.12.6 Conclusion .....	27
4.13	Vanadium.....	27
	4.13.1 Summary of Process Knowledge .....	27
	4.13.2 Evaluation of Spatial Trends.....	28
	4.13.3 Pattern Recognition.....	28
	4.13.4 Comparison to RFETS Background and Other Background Data Sets.....	28
	4.13.5 Risk Potential for Plants and Wildlife .....	28
	4.13.6 Conclusion .....	29
4.14	Zinc .....	29
	4.14.1 Summary of Process Knowledge .....	29
	4.14.2 Evaluation of Spatial Trends.....	29
	4.14.3 Pattern Recognition.....	29
	4.14.4 Comparison to RFETS Background and Other Background Data Sets.....	29
	4.14.5 Risk Potential for Plants and Wildlife .....	30
	4.14.6 Conclusion .....	30
5.0	REFERENCES.....	30

### LIST OF TABLES

Table A3.2.1	Statistical Distribution and Comparison to Background for LWNEU Surface Soil and Surface Sediment
Table A3.2.2	Summary Statistics for LWNEU Surface Soil and Surface Sediment
Table A3.2.3	Statistical Distribution and Comparison to Background for LWNEU Subsurface Soil and Subsurface Sediment

Table A3.2.4	Summary Statistics for LWNEU Subsurface Soil and Subsurface Sediment
Table A3.2.5	Statistical Distribution and Comparison to Background for LWNEU Surface Soil Non-PMJM Receptors
Table A3.2.6	Summary Statistics for LWNEU Surface Soil Non-PMJM Receptors
Table A3.2.7	Statistical Distribution and Comparison to Background for Surface Soil in PMJM Habitat
Table A3.2.8	Summary Statistics for LWNEU Surface Soil in PMJM Habitat
Table A3.2.9	Statistical Distribution and Comparison to Background for Subsurface Soil
Table A3.2.10	Summary Statistics for Subsurface Soil
Table A3.4.1	Summary of Element Concentrations in Colorado and Bordering States Surface Soil

#### LIST OF FIGURES

Figure A3.2.1	LWNEU Surface Soil Box Plots for Aluminum
Figure A3.2.2	LWNEU Surface Soil/Surface Sediment Box Plots for Arsenic
Figure A3.2.3	LWNEU Surface Soil Box Plots for Arsenic (Non-PMJM)
Figure A3.2.4	LWNEU Surface Soil Box Plots for Arsenic (PMJM)
Figure A3.2.5	LWNEU Subsurface Soil Box Plots for Arsenic
Figure A3.2.6	LWNEU Surface Soil Box Plots for Barium (Non-PMJM)
Figure A3.2.7	LWNEU Surface Soil Box Plots for Cadmium (Non-PMJM)
Figure A3.2.8	LWNEU Surface Soil/Surface Sediment Box Plots for Cesium-134
Figure A3.2.9	LWNEU Surface Soil/Surface Sediment Box Plots for Cesium-137
Figure A3.2.10	LWNEU Surface Soil Box Plots for Chromium (Non-PMJM)
Figure A3.2.11	LWNEU Surface Soil Box Plots for Chromium (PMJM)
Figure A3.2.12	LWNEU Surface Soil Box Plots for Copper (Non-PMJM)

- Figure A3.2.13 LWNEU Surface Soil Box Plots for Lead (Non-PMJM)
- Figure A3.2.14 LWNEU Surface Soil Box Plots for Lithium (Non-PMJM)
- Figure A3.2.15 LWNEU Surface Soil Box Plots for Manganese (Non-PMJM)
- Figure A3.2.16 LWNEU Surface Soil Box Plots for Manganese (PMJM)
- Figure A3.2.17 LWNEU Surface Soil Box Plots for Mercury (Non-PMJM)
- Figure A3.2.18 LWNEU Surface Soil Box Plots for Nickel (Non-PMJM)
- Figure A3.2.19 LWNEU Surface Soil Box Plots for Nickel (PMJM)
- Figure A3.2.20 LWNEU Subsurface Soil/Subsurface Sediment Box Plots for Radium-228
- Figure A3.2.21 LWNEU Surface Soil Box Plots for Vanadium (Non-PMJM)
- Figure A3.2.22 LWNEU Surface Soil Box Plots for Vanadium (PMJM)
- Figure A3.2.23 LWNEU Surface Soil Box Plots for Zinc (Non-PMJM)
- Figure A3.2.24 LWNEU Surface Soil Box Plots for Zinc (PMJM)
- Figure A3.4.1 Probability Plot for Aluminum Concentrations (Natural Logarithm) in LWNEU Surface Soil
- Figure A3.4.2a Probability Plot for Antimony Concentrations (Natural Logarithm) in LWNEU Surface Soil (Includes both detected and nondetected antimony concentrations)
- Figure A3.4.2b Probability Plot of Detected Antimony Concentrations (Natural Logarithm) in LWNEU Surface Soil (Nondetects have been removed)
- Figure A3.4.3 Probability Plot for Arsenic Concentrations (Natural Logarithm) in LWNEU Surface Soil/Surface Sediment
- Figure A3.4.4 Probability Plot for Boron Concentrations (Natural Logarithm) in LWNEU Surface Soil
- Figure A3.4.5 Probability Plot for Chromium Concentrations (Natural Logarithm) in LWNEU Surface Soil
- Figure A3.4.6 4,4'-DDT Concentrations in Sitewide Surface Soil (Non-PMJM)
- Figure A3.4.7 Probability Plot for Lithium Concentrations (Natural Logarithm) in LWNEU Surface Soil

- Figure A3.4.8 Probability Plot for Molybdenum Concentrations (Natural Logarithm) in LWNEU Surface Soil
- Figure A3.4.9 Probability Plot for Nickel Concentrations (Natural Logarithm) in LWNEU Surface Soil
- Figure A3.4.10 Radium-228 Concentrations in Sitewide Surface Soil and Surface Sediment
- Figure A3.4.11a Probability Plot for Selenium Concentrations (Natural Logarithm) in LWNEU Surface Soil (Includes both detected and nondetected concentrations)
- Figure A3.4.11b Probability Plot of Detected Selenium Concentrations (Natural Logarithm) in LWNEU Surface Soils
- Figure A3.4.12 Probability Plot for Tin Concentrations (Natural Logarithm) in LWNEU Surface Soil
- Figure A3.4.13 Probability Plot for Vanadium Concentrations (Natural Logarithm) in LWNEU Surface Soil
- Figure A3.4.14 Probability Plot for Zinc Concentrations (Natural Logarithm) in LWNEU Surface Soil

## ACRONYMS AND ABBREVIATIONS

µg/kg	microgram per kilogram
AL	action level
CDH	Colorado Department of Health
CDPHE	Colorado Department of Public Health and Environment
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
DQA	Data Quality Assessment
ECOI	ecological contaminant of interest
EcoSSL	Ecological Soil Screening Level
ECOPC	ecological contaminant of potential concern
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ESL	ecological screening level
EU	Exposure Unit
GIS	Geographical Information System
HEPA	High-Efficiency Particulate Air
HHRA	Human Health Risk Assessment
HRR	Historical Release Report
IA	Industrial Area
IAEU	Industrial Area Exposure Unit
IHSS	Individual Hazardous Substance Site
LWOEU	Lower Woman Drainage Exposure Unit

LWNEU	Lower Walnut Drainage Exposure Unit
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
NCP	National Contingency Plan
NFA	No Further Action
NNEU	No Name Gulch Exposure Drainage Unit
NOAEL	no observed adverse effect level
OU	Operable Unit
PAC	Potential Area of Concern
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
PCOC	potential contaminant of concern
PDSR	Pre-Demolition Survey Report
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
RCEU	Rock Creek Drainage Exposure Unit
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
RLCR	Reconnaissance-Level Characterization Reports
tESL	threshold ESL
UBC	Under Building Contamination
UCL	upper confidence limit
UTL	upper tolerance limit
WRS	Wilcoxon Rank Sum

WRW

wildlife refuge worker

## 1.0 INTRODUCTION

This attachment presents the results for the statistical analyses and professional judgment evaluation used to select human health contaminants of concern (COCs) as part of the Human Health Risk Assessment (HHRA) and ecological contaminants of potential concern (ECOPCs) as part of the Ecological Risk Assessment (ERA) for the Lower Walnut Drainage Exposure Unit (EU) (LWNEU) at the Rocky Flats Environmental Technology Site (RFETS). The methods used to perform the statistical analysis and develop the professional judgment sections are described in Sections 2.2.5 (HHRA) and 2.3.4 (ERA) of Appendix A, Volume 2 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation (RI)/Corrective Measures Study (CMS)-Feasibility Study (FS) Report (hereafter referred to as the RI/FS Report) and follow the Final Comprehensive Risk Assessment (CRA) Work Plan and Methodology (DOE 2005).

## 2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE LOWER WALNUT DRAINAGE EXPOSURE UNIT

The results of the statistical background comparisons for inorganic and radionuclide potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) in surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil samples collected from the LWNEU are presented in this section. Box plots are provided for analytes that were carried forward into the statistical comparison step and are presented in Figures A3.2.1 to A3.2.24.<sup>1</sup> The box plots display several reference points: 1) the line inside the box is the median; 2) the lower edge of the box is the 25th percentile; 3) the upper edge of the box is the 75th percentile; 4) the upper lines (called whiskers) are drawn to the greatest value that is less than or equal to 1.5 times the inter-quartile range (the inter-quartile range is between the 75th and 25th percentiles); 5) the lower whiskers are drawn to the lowest value that is greater than or equal to 1.5 times the inter-quartile range; and 6) solid circles are data points greater or less than the whiskers.

PCOCs with concentrations in the LWNEU that are statistically greater than background (or if background comparisons were not performed) are carried through to the professional judgment step of the COC/ECOPC selection processes. ECOIs (for non-Preble's meadow jumping mouse [PMJM] receptors) with concentrations in the LWNEU that are statistically greater than background (or if background comparisons are not

---

<sup>1</sup> Statistical background comparisons are not performed for analytes if: 1) the background concentrations are nondetections; 2) background data are unavailable; 3) the analyte has low detection frequency in the LWNEU or background data set (less than 20 percent); or 4) the analyte is an organic compound. Box plots are not provided for these analytes. However, these analytes are carried forward into the professional judgment evaluation.

performed) are carried through to the exposure point concentration (EPC)-to-threshold ecological screening level (ESL) comparison step of the ECOPC selection processes.

PCOCs and ECOIs with concentrations that are not statistically greater than background are not identified as COCs/ECOPCs and are not evaluated further.

## **2.1 Surface Soil/Surface Sediment Data Used in the HHRA**

For the LWNEU surface soil/surface sediment data set, the maximum detected concentrations (MDCs) for iron and manganese exceeded the wildlife refuge worker (WRW) preliminary remediation goals (PRGs), but their upper confidence limits (UCLs) on the mean concentration for the site data set did not exceed the PRG. Consequently, iron and manganese were not evaluated further.

The MDCs and UCLs for arsenic, cesium-134, cesium-137, and radium-228 exceed the PRGs for the LWNEU data set and were carried forward into the statistical background comparison step. The results of the statistical comparison of the LWNEU surface soil/surface sediment data to background data for these four analytes are presented in Table A3.2.1, while the summary statistics for background and LWNEU surface soil/surface sediment data are shown in Table A3.2.2.

The results of the statistical comparisons of the LWNEU surface soil/surface sediment data to background data indicate the following:

### ***Analytes Statistically Greater than Background at the 0.1 Significance Level***

- Arsenic

### ***Analytes Not Statistically Greater than Background at the 0.1 Significance Level***

- Cesium-134
- Cesium-137

### ***Background Comparison Not Performed***

- Radium-228

## **2.2 Subsurface Soil/Subsurface Sediment Data Used in the HHRA**

The MDC and UCL for radium-228 exceed the PRG for the LWNEU data set and radium-228 was carried forward into the statistical background comparison step. The results of the statistical comparison of the LWNEU subsurface soil/subsurface sediment data to background data for radium-228 are presented in Table A3.2.3, while the summary statistics for background and LWNEU subsurface soil/subsurface sediment data are shown in Table A3.2.4.

The results of the statistical comparisons of the LWNEU subsurface soil/subsurface sediment data to background data indicate the following:

***Analytes Statistically Greater than Background at the 0.1 Significance Level***

- None

***Analytes Not Statistically Greater than Background at the 0.1 Significance Level***

- Radium-228

***Background Comparison Not Performed<sup>1</sup>***

- None

**2.3 Surface Soil Data Used in the ERA (Non-PMJM Receptors)**

For the LWNEU surface soil data set, the MDCs for aluminum, antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, tin, vanadium, and zinc exceeded a non-PMJM ESL and, consequently, these analytes were carried forward into the statistical background comparison step. The statistical background comparison is not performed for organics, so 4,4'-DDT was carried forward in the EPC versus tESL comparison step. The results of the statistical comparison of the LWNEU surface soil data to background data are presented in Table A3.2.5 and the summary statistics for background and LWNEU surface soil data are shown in Table A3.2.6.

The results of the statistical comparisons of the LWNEU surface soil to background data indicate the following:

***Analytes Statistically Greater than Background at the 0.1 Significance Level***

- Aluminum
- Barium
- Chromium
- Lithium
- Nickel
- Vanadium
- Zinc

***Analytes Not Statistically Greater than Background at the 0.1 Significance Level***

- Arsenic
- Cadmium
- Copper

- Lead
- Manganese
- Mercury

***Background Comparison Not Performed<sup>1</sup>***

- Antimony
- Boron
- Molybdenum
- Selenium
- Tin

**2.4 Surface Soil Data Used in the ERA (PMJM Receptors)**

The MDCs for arsenic, chromium, manganese, nickel, vanadium, and zinc exceed the ESLs for the PMJM receptor for the LWNEU surface soil data set (i.e., samples within the PMJM habitat areas) and were carried forward into the background comparison step. The results of the statistical comparison of the LWNEU surface soil data to background data are presented in Table A3.2.7 and the summary statistics for background and LWNEU surface soil data are shown in Table A3.2.8.

The results of the statistical comparisons of the LWNEU surface soil for PMJM receptors to background data indicate the following:

***Analytes Statistically Greater than Background at the 0.1 Significance Level***

- Chromium
- Nickel

***Analytes Not Statistically Greater than Background at the 0.1 Significance Level***

- Arsenic
- Manganese
- Vanadium
- Zinc

***Background Comparison Not Performed<sup>1</sup>***

- None

## 2.5 Subsurface Soil Data used in the ERA

The MDC for arsenic exceeded an ESL for burrowing receptors for the LWNEU subsurface soil data set, and was carried forward into the statistical background comparison. The results of the statistical comparison of the LWNEU subsurface soil data to background data are presented in Table A3.2.9 and the summary statistics for background and LWNEU surface soil data are shown in Table A3.2.10.

The results of the statistical comparisons of the LWNEU subsurface soil for burrowing receptors to background data indicate the following:

### *Analytes Statistically Greater than Background at the 0.1 Significance Level*

- Arsenic

### *Analytes Not Statistically Greater than Background at the 0.1 Significance Level*

- None

### *Background Comparison Not Performed<sup>1</sup>*

- None

## 3.0 UPPER-BOUND EXPOSURE POINT CONCENTRATION COMPARISON TO LIMITING ECOLOGICAL SCREENING LEVELS

ECOs in surface soil and subsurface soil with concentrations that are statistically greater than background (or if background comparisons were not performed) are evaluated further by comparing the EPC concentrations to the threshold ESLs (tESLs). The upper-bound EPCs are the 95 percent UCL of the 90th percentile [upper tolerance limit (UTL)] for small home-range receptors, the UCL for large home-range receptors, or the MDC in the event that the UCL or UTL is greater than the MDC.

ECOs in surface soil for PMJM receptors are not screened against tESLs. They are carried forward to the professional judgment evaluation.

### 3.1 ECOs in Surface Soil (Non-PMJM)

Of the 13 ECOs (aluminum, antimony, barium, boron, chromium, lithium, molybdenum, nickel, selenium, tin, vanadium, zinc and 4,4'-DDT) whose concentrations were considered to be statistically greater than background only barium as found to have an upper-bound EPC lower than the tESLs. Therefore, barium was not carried forward into the professional judgment step.

The other 12 ECOs (aluminum, antimony, boron, chromium, lithium, molybdenum, nickel, selenium, tin, vanadium, zinc, and 4,4'-DDT) were found to have upper-bound EPCs greater than the tESLs. These 12 ECOs are evaluated in the professional judgment evaluation screening step (Section 4.0).

### 3.2 ECOIs in Surface Soil (PMJM)

ECOIs in surface soil for PMJM receptors are not screened against tESLs. They are carried forward to the professional judgment evaluation. Therefore, chromium and nickel are carried forward into the professional judgment step.

### 3.3 ECOIs in Subsurface Soil

Arsenic was found to be statistically greater than background and above an ESL in accordance with the ECOPC selection process. However, arsenic was not found to have upper-bound EPCs greater than the tESLs and was not carried forward into the professional judgment step.

## 4.0 PROFESSIONAL JUDGMENT

This section presents the results of the professional judgment step of the COC and ECOPC selection processes for the HHRA and ERA, respectively. Based on the weight of evidence evaluated in the professional judgment step, PCOCs and ECOIs are either included for further evaluation as COCs/ECOPCs in the risk characterization step, or excluded from further evaluation.

The professional judgment evaluation takes into account the following lines of evidence: process knowledge, spatial trends, pattern recognition<sup>2</sup>, comparison to RFETS background and regional background data sets (see Table A3.4.1 for a summary of regional background data)<sup>3</sup>, and risk potential. For PCOCs or ECOIs where the process knowledge and/or spatial trends indicate that the presence of the analyte in the EU may be a result of historical site-related activities, the professional judgment discussion

---

<sup>2</sup> The pattern recognition evaluation includes the use of probability plots. If two or more distinct populations are evident in the probability plot, this suggests that one or more local releases may have occurred. Conversely, if only one distinct low-concentration population is defined, likely representing a background population, a local release may or may not have occurred. Similar to all statistical methods, the probability plot has limitations in cases where there is inadequate sampling and the magnitude of the release is relatively small. Thus, absence of two clear populations in the probability plots is consistent with, but not definitive proof of, the hypothesis that no releases have occurred. However, if a release has occurred within the sampled area and has been included in the samples, then the elemental concentrations associated with that release are either within the background concentration range or the entire sampled population represents a release, a highly unlikely probability.

<sup>3</sup> The regional background data set for Colorado and the bordering states was extracted from data for the western United States (Shacklette and Boerngen 1984), and is composed of data from Colorado as well as Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming. Although the Colorado and bordering states background data set is not specific to Colorado's Front Range, it is useful for the professional judgment evaluation in the absence of a robust data set for the Front Range. Colorado's Front Range has highly variable terrain that changes elevation over short distances. Consequently, numerous soil types and geologic materials are present at RFETS, and the data set for Colorado and bordering states may be more representative of these variable soil types.

includes only two of the lines of evidence listed above, and it is concluded that these analytes are COCs/ECOPCs and are carried forward into risk characterization. For the other PCOCs and ECOIs that are evaluated in the professional judgment step, each of the lines of evidence listed above are included in the discussion.

For metals, Appendix A, Volume 2, Attachment 8, of the RI/FS report provides the details of the process knowledge and spatial trend evaluations. The conclusions from these evaluations are noted in this attachment.

The following PCOCs/ECOIs are evaluated further in the professional judgment step for LWNEU:

- Surface soil/surface sediment (HHRA)
  - Arsenic
  - Radium-228
- Surface soil for non-PMJM receptors (ERA)
  - Aluminum
  - Antimony
  - Boron
  - Chromium
  - Lithium
  - Molybdenum
  - Nickel
  - Selenium
  - Tin
  - Vanadium
  - Zinc
  - 4,4'-DDT
- Surface soil for PMJM receptors (ERA)
  - Chromium
  - Nickel

The following sections provide the professional judgment evaluations, by analyte and then by medium, for the PCOCs/ECOIs listed above.

#### 4.1 Aluminum

Aluminum has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of

evidence used to determine if aluminum should be retained for risk characterization are summarized below.

#### **4.1.1 Summary of Process Knowledge**

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge suggests aluminum may be present in RFETS soils as a result of historical site-related activities because of large aluminum metal inventory and presence of aluminum in waste generated during former operations. However, these sources of historic use are remote from LWNEU.

#### **4.1.2 Evaluation of Spatial Trends**

##### ***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that aluminum concentrations in LWNEU surface soil reflect variations in naturally occurring aluminum.

#### **4.1.3 Pattern Recognition**

##### ***Surface Soil (Non-PMJM)***

The probability plot for the natural log transformed data set for aluminum (Figure A3.4.1) indicates the presence of a single background population. The plot is complicated by the apparent inclusion of nondetected concentrations forming a horizontal step that projects off the background line.

#### **4.1.4 Comparison to RFETS Background and Other Background Data Sets**

##### ***Surface Soil (Non-PMJM)***

Aluminum was detected at all 22 sampling locations within LWNEU, but the MDC was lower than background MDC. Aluminum concentrations in surface soil at LWNEU range from 7,460 to 17,000 milligrams per kilogram (mg/kg), with a mean concentration of 11,912 mg/kg and a standard deviation of 2,424 mg/kg (Table A3.2.6). Background aluminum concentrations range from 4,050 to 17,100 mg/kg, with a mean concentration of 10,203 mg/kg and a standard deviation of 3,256 mg/kg. The ranges of the LWNEU and background data sets significantly overlap and the LWNEU aluminum MDC does not exceed the site background MDC.

In addition to aluminum MDC being lower than the site background MDC, aluminum concentrations at the LWNEU are well within the range of reported literature values. Aluminum concentrations reported in surface soil samples at the LWNEU are well within the range for aluminum in soils of Colorado and the bordering states, which range from 5,000 to 100,000 mg/kg, with mean concentration of 50,800 mg/kg and a standard deviation of 23,500 mg/kg (Table A3.4.1).

#### **4.1.5 Risk Potential for Plants and Wildlife**

##### ***Surface Soil (Non-PMJM)***

The MDC for aluminum in the LWNEU (17,000 mg/kg) exceeds the no observed adverse effect level (NOAEL) ESL for only one receptor group, terrestrial plants (50 mg/kg). However, U.S. Environmental Protection Agency (EPA) Ecological Soil Screening Level (EcoSSL) guidance (EPA 2003) for aluminum recommends that aluminum not be considered an ECOPC for soils at sites where the soil pH exceeds 5.5 due to its limited bioavailability in non-acidic soils. The average pH value for RFETS surface soils is 8.2.

Aluminum concentrations in the LWNEU show a distribution similar to sitewide background concentrations and there are no historical records of a source area in the LWNEU. Therefore, it is unlikely that the aluminum concentrations in surface soil within the LWNEU could represent potential risk concerns for wildlife populations.

#### **4.1.6 Conclusion**

Review of process knowledge indicates that aluminum is unlikely to be present in LWNEU soils as a result of historical site-related activities; the weight of evidence presented above shows that aluminum concentrations in LWNEU surface soil (non-PMJM receptors) have a spatial distribution and single data population indicative of naturally occurring aluminum, are well within regional background levels, and are unlikely to result in risk concerns for wildlife populations. Aluminum is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

#### **4.2 Antimony**

Antimony has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if antimony should be retained for risk characterization are summarized below.

##### **4.2.1 Summary of Process Knowledge**

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates antimony is unlikely to be present in RFETS soil as a result of historical site-related activities.

##### **4.2.2 Evaluation of Spatial Trends**

##### ***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that antimony concentrations in LWNEU surface soil reflect variations in naturally occurring antimony.

#### **4.2.3 Pattern Recognition**

##### ***Surface Soil (Non-PMJM)***

The probability plot for the natural log transformed data set for antimony (Figure A3.4.2a) contains many nondetected concentrations and it is therefore difficult to perform a definitive evaluation. However, a total range of antimony from 0.16 to 6.8 mg/kg suggests the possibility that these sample points represent a background population. Figure A3.4.2a is a probability plot assuming that all 14 antimony concentrations are detects resulting in sample points deviating broadly from the trend line. A total of 14 samples is generally too small a population to estimate a background population. Figure A3.4.2b is a plot of the four detected antimony concentrations on a probability scale. The probability plots are inconclusive because there are too few samples to estimate a background population for antimony.

#### **4.2.4 Comparison to RFETS Background and Other Background Data Sets**

##### ***Surface Soil (Non-PMJM)***

Antimony was detected in four of the 14 surface soil samples collected in the LWNEU. Detected antimony concentrations at the LWNEU range from 0.49 to 1.0 mg/kg, with a mean concentration of 2.10 mg/kg and a standard deviation of 2.87 mg/kg (Table A3.2.6). Reported detection limits range from 0.31 to 13.6 mg/kg. None of the background antimony sample results were detects; detection limits varied from 0.38 to 0.94 mg/kg.

The reported range of detected antimony concentrations in surface soils of Colorado and the bordering states range from 1.0 to 2.5 mg/kg, with an arithmetic mean of 0.65 mg/kg (Table A3.4.1). Antimony concentrations reported in surface soil samples at the LWNEU (0.49 to 1.0 mg/kg) are well within this lower range for soils in Colorado and bordering states.

#### **4.2.5 Risk Potential for Plants and Wildlife**

##### ***Surface Soil (Non-PMJM)***

The antimony UTL of 6.80 mg/kg exceeded the ESL for three receptor groups: the insectivorous deer mouse, the insectivorous coyote ESL (3.85 mg/kg), and the terrestrial plants (5.0 mg/kg). The ESLs for all other non-PMJM receptors were greater than the LWNEU antimony MDC and UTL and range from 13.0 to 138 mg/kg. It is important to note that the antimony UTL was greater than the MDC in LWNEU surface soil because its calculation included half of the nondetected concentrations, some of which may have had high detection limits.

#### 4.2.6 Conclusion

The weight of evidence presented above shows that antimony concentrations in surface soil in the LWNEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. Additionally, there is no evidence of a release from potential sources inside or outside the EU that would impact antimony concentrations in surface soil. The one historical IHSS located within the LWNEU is associated with sediments in the Flume Pond and not surface soil. In addition, antimony was not detected at concentrations that are likely to cause risk to ecological receptor populations. Antimony is not considered an ECOPC in surface soil for the LWNEU and is not further evaluated quantitatively.

#### 4.3 Arsenic

Arsenic has concentrations statistically greater than background in surface soil/surface sediment and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if arsenic should be retained for risk characterization are summarized below.

##### 4.3.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates arsenic is unlikely to be present in RFETS soil as a result of historical site-related activities.

##### 4.3.2 Evaluation of Spatial Trends

###### *Surface Soil/ Surface Sediment*

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that arsenic concentrations in LWNEU surface soil/surface sediment reflect variations in naturally occurring arsenic.

##### 4.3.3 Pattern Recognition

###### *Surface Soil/Surface Sediment*

The probability plot for the natural log-transformed data set for arsenic in combined in surface soil and surface sediment within LWNEU (Figure A3.4.3) suggests that arsenic concentrations form a single background population. One sample (SS20032.WC) which has the lowest arsenic concentration (2.2 mg/kg) falls below the background line probably reflecting the somewhat minor number of samples with arsenic concentrations below about 3.0 mg/kg in the data set.

#### **4.3.4 Comparison to RFETS Background and Other Background Data Sets**

##### ***Surface Soil/Surface Sediment***

Arsenic was detected in each of the 25 surface soil/surface sediment samples collected in the LWNEU. Arsenic concentrations in surface soil/surface sediment at the LWNEU range from 2.2 to 9.4 mg/kg, with a mean concentration of 5.45 mg/kg and a standard deviation of 1.56 mg/kg. Arsenic concentrations in the background data set range from 0.270 to 9.60 mg/kg, with a mean concentration of 3.42 mg/kg and a standard deviation of 2.55 mg/kg (Table A3.2.2). The ranges of the LWNEU and background data sets overlap, and the LWNEU surface soil/surface sediment arsenic MDC does not exceed the site background MDC.

Arsenic concentrations reported in surface soil samples at the LWNEU are well within the range for arsenic in soils of Colorado and the bordering states, which range from 1.22 to 97 mg/kg, with a mean concentration of 6.9 mg/kg and a standard deviation of 7.64 mg/kg (Table A3.4.1).

#### **4.3.5 Risk Potential for HHRA**

##### ***Surface Soil/Surface Sediment***

The LWNEU arsenic MDC for surface soil/surface sediment is 9.40 mg/kg and the UCL is 5.79 mg/kg. Although the UCL of 5.79 mg/kg is slightly more than two times greater than the PRG (2.41 mg/kg), the LWNEU surface soil/surface sediment arsenic MDC of 9.40 mg/kg is less than the site background MDC of 9.60 mg/kg. Because the PRG is based on an excess carcinogenic risk of  $1\text{E-}06$ , the cancer risk based on the UCL concentration is less than  $4\text{E-}06$ , and is well within the National Contingency Plan (NCP) risk range of  $1\text{E-}06$  to  $1\text{E-}04$ . The background UCL for arsenic in surface soil/surface sediment is 4.03 mg/kg (Appendix A, Attachment 9 of the RI/FS Report), which equates to a cancer risk of  $2\text{E-}06$ . Therefore, the excess cancer risks to the WRW from exposure to arsenic in surface soil/surface sediment in the LWNEU are similar to background risks.

#### **4.3.6 Conclusion**

The weight of evidence presented above shows that arsenic concentrations in LWNEU surface soil/surface sediment are not likely to be a result of historical site-related activities based on process knowledge, the spatial distribution trend and the single data population indicative of naturally occurring arsenic. In addition, the MDC for LWNEU arsenic in surface soil and surface sediment does not exceed the background MDC. Arsenic is not considered COC in surface soil/surface sediment for the LWNEU. Therefore, arsenic is not further evaluated quantitatively.

#### **4.4 Boron**

Boron has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence

used to determine if boron should be retained for risk characterization are summarized below.

#### **4.4.1 Summary of Process Knowledge**

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates boron is unlikely to be present in RFETS soil as a result of historical site-related activities.

#### **4.4.2 Evaluation of Spatial Trends**

##### ***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that boron concentrations in LWNEU surface soil reflect variations in naturally occurring boron.

#### **4.4.3 Pattern Recognition**

##### ***Surface Soil (Non-PMJM)***

The probability plot for the natural log-transformed data set for boron (Figure A3.4.4) indicates the presence of a single background population.

#### **4.4.4 Comparison to RFETS Background and Other Background Data Sets**

##### ***Surface Soil (Non-PMJM)***

RFETS background data were not collected for boron. However, the reported range for boron in surface soil within Colorado and the bordering states is 20 to 150 mg/kg, with a mean concentration of 27.9 mg/kg and a standard deviation of 19.7 mg/kg (Table A3.4.1). Boron concentrations reported in surface soil samples at the LWNEU ranged from 2.75 to 8.40 mg/kg, with a mean concentration of 4.89 mg/kg and a standard deviation of 1.43 mg/kg (Table A3.2.6). The range of boron concentrations in surface soil at the LWNEU are well within the range for boron in soils of Colorado and the bordering states.

#### **4.4.5 Risk Potential for Plants and Wildlife**

##### ***Surface Soil (Non-PMJM)***

The MDC for boron in the LWNEU (10.4 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (0.5 mg/kg). All other NOAEL ESLs were greater than the MDC and ranged from 30 to 6,070 mg/kg. Site-specific background data for boron were not available, but the MDC of 8.40 did not exceed the low end (20 mg/kg) of the background range presented in Shacklette and Boerngen (1984). This indicates the terrestrial plant NOAEL ESL (0.5 mg/kg) is well below expected background

concentrations, and MDCs above the NOAEL ESL are not likely to be indicative of site-related risk to the terrestrial plant community in the LWNEU. Kabata-Pendias and Pendias (1992) indicate soil with boron concentrations equal to 0.3 mg/kg is critically deficient in boron, and effects on plant reproduction would be expected. Additionally, the summary of boron toxicity in Efroymson et al. (1997) notes that the source of the 0.5-mg/kg NOAEL ESL indicates boron was toxic when added at 0.5 mg/kg to soil, but gives no indication of the boron concentration in the baseline soil before the addition. The confidence placed by Efroymson et al. (1997) was low. Because no NOAEL ESLs other than the terrestrial plant NOAEL ESL are exceeded by the MDC, boron is highly unlikely to present a risk to terrestrial receptor populations in the LWNEU.

#### **4.4.6 Conclusion**

The weight of evidence presented above shows that boron concentrations in LWNEU surface soil (non-PMJM receptors) are unlikely to be a result of historical site-related activities based on process knowledge, and that the spatial distribution trend and the single data population are indicative of naturally occurring boron. In addition, LWNEU surface soil concentrations for boron are well within regional background levels and are unlikely to result in risk concerns for wildlife populations. Boron is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

#### **4.5 Chromium**

Chromium had an upper-bound exposure point concentration (EPC) in surface soil (for non-PMJM receptors) greater than the limiting threshold ecological screening level (tESL) so was carried forward to the professional judgment step per the CRA methodology. In addition, chromium in surface soil (for PMJM receptors) had concentrations statistically greater than background so was carried forward to the professional judgment step. The lines of evidence used to determine if chromium should be retained as an ECOPC are summarized below.

##### **4.5.1 Summary of Process Knowledge**

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for chromium to have been released into RFETS soil because of the moderate chromium metal inventory and presence of chromium in waste generated during former operations. Spills of chromium have occurred at RFETS. However, the historical sources of chromium are remote from LWNEU. Therefore, chromium is unlikely to be present in LWNEU soil as of historic site-related activities.

## 4.5.2 Evaluation of Spatial Trends

### *Surface Soil (non-PMJM)*

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that chromium concentrations in LWNEU surface soil reflect variations in naturally occurring chromium.

### *Surface Soil (PMJM)*

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that chromium concentrations in PMJM habitat surface soil in LWNEU reflect variations in naturally occurring chromium.

## 4.5.3 Pattern Recognition

### *Surface Soil (non-PMJM and PMJM))*

The probability plot for the natural log-transformed data set for chromium (Figure A3.4.5) contains at least two horizontal step concentrations causing the probable single background population distribution along the line to be variable. All of the 21 chromium concentrations are detected concentrations, therefore, there are probably at least two mineral phase conditions in the soils that are apparently controlling the chromium concentration at a quasi-equilibrium condition resulting in these horizontal step functions on the probability plot.

## 4.5.4 Comparison to RFETS Background and Other Background Data Sets

### *Surface Soil (non-PMJM)*

Chromium concentrations in the 22 surface soil samples at the LWNEU for non-PMJM habitats range from 7.92 to 21.0 mg/kg, with a mean concentration of 13.4 mg/kg and a standard deviation of 2.97 mg/kg (Table A3.2.6). Background concentrations of chromium range from 5.5 to 16.9 mg/kg, with a mean concentration of 11.2 mg/kg and a standard deviation of 2.78 mg/kg (Table A3.2.6).

The reported background concentrations for chromium in surface soils of Colorado and bordering states range from 3 to 500 mg/kg, with an arithmetic mean of 48 mg/kg (Table A3.4.1). Chromium concentrations reported in surface soil samples at the LWNEU (7.9 to 21.0 mg/kg) are well within this range.

### *Surface Soil (PMJM)*

Chromium concentrations in nine surface soil samples at the LWNEU for PMJM habitats range from 7.92 to 21.0 mg/kg, with a mean concentration of 13.1 mg/kg and a standard deviation of 3.68 mg/kg (Table A3.2.8). Background concentrations of chromium range from 5.5 to 16.9 mg/kg, with a mean concentration of 11.2 mg/kg and a standard deviation of 2.78 mg/kg (Table A3.2.8).

The reported background concentrations for chromium in surface soils of Colorado and bordering states range from 3 to 500 mg/kg, with an arithmetic mean of 48 mg/kg

(Table A3.4.1). Chromium concentrations reported in LWNEU surface soil for PMJM receptors (7.9 to 21.0 mg/kg) are well within the regional chromium background concentrations in surface soil.

#### **4.5.5 Risk Potential for Plants and Wildlife**

##### ***Surface Soil (Non-PMJM)***

The UTL for chromium in the LWNEU (19.0 kg/kg) exceeds the NOAEL ESLs for five receptor groups, terrestrial invertebrate (0.4 mg/kg), terrestrial plant (1.0 mg/kg), insectivorous mourning dove (1.34 mg/kg), American kestrel (14.0 mg/kg), and insectivore deer mouse (16.0 mg/kg). All of these ESLs are less than the maximum detected concentration in background surface soils. All other NOAEL ESLs were greater than the UTL and ranged from 25.0 to 4,173.0 mg/kg. The chromium ESLs are based on toxicity to hexavalent chromium, of which is likely to represent only a small fraction of the total chromium detected in soils. The mammalian ESLs for trivalent chromium are considerably greater than the hexavalent chromium ESLs. This indicates that the ESL based on hexavalent chromium may be overly conservative for use in assessing risk to the PMJM.

##### ***Surface Soil (PMJM)***

The MDC for chromium in the LWNEU (21.0 mg/kg) exceeds the NOAEL ESL for PMJM (19.3). The chromium ESL is based on toxicity to hexavalent chromium, of which is likely to represent only a small fraction of the total chromium detected in soils. The PMJM ESL for trivalent chromium is equal to 16,100 mg/kg. This indicates that the ESL based on hexavalent chromium may be overly conservative for use in assessing risk to the PMJM.

#### **4.5.6 Conclusion**

The weight of evidence presented above shows that chromium concentrations in LWNEU surface soil (PMJM and non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge, a spatial distribution that suggests chromium is naturally occurring, a probability plot that suggests the presence of a single population which is also indicative of background conditions, and LWNEU concentrations that are well within regional background levels. Chromium is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

#### **4.6 4,4'-DDT**

4,4'-DDT exceeded NOAEL ESLs in surface soil for non-PMJM so was carried forward to the professional judgment step. The lines of evidence used to determine if 4,4'-DDT should be retained as an ECOPC are summarized below.

#### 4.6.1 Summary of Process Knowledge

Based on a review of site historical information, it is highly unlikely that there were releases of 4,4'-DDT to the environment. 4,4'-DDT was not identified as a COC in the Operable Unit (OU) 2 903 Pad, Mound, and East Trenches Area Risk Assessment (DOE, 1995). There is one historical IHSS (Flume Pond, IHSS 142.12) present in the LWNEU. This historical IHSS contains pond sediments and stream sediments that were assessed in the Draft OU 6 RFI/RI Report, and 4,4'-DDT was not identified as a COC in stream sediments in McKay Ditch or in the Flume Pond Effluent sediments (DOE, 1996). OU 2 and OU 6 areas were both in the vicinity of the 4,4'-DDT detection. All four of the surface soil sample results for 4,4'-DDT sitewide were reported in 1993 and were available for these reports.

#### 4.6.2 Summary of Spatial Trends

##### *Surface Soil (Non-PMJM)*

Figure A3.4.6 shows that, of the four samples collected within LWNEU, 4,4'-DDT was detected in only one location at a concentration of 26.0 µg/kg. In the adjacent Windblown area, there are 40 sample results for 4,4'-DDT and none showed a detection. Also, there are no detections of 4,4'-DDT in stream sediments in North Walnut Creek, South Walnut Creek, or McKay Ditch (DOE, 1996).

#### 4.6.3 Conclusion

Although 4,4'-DDT is not associated with site activities in the LWNEU and it was detected in only one of four sampling locations, a decision could not be made whether the single detected concentration in the samples collected from the LWNEU is significantly elevated compared to background because the background comparison is not performed for organics. Because the single 4,4'-DDT detected concentration of 26.0 µg/kg exceeded two NOAEL ESLs, insectivorous mourning dove (1.20 µg/kg) and American kestrel (3.34 µg/kg), as a conservative measure, 4,4'-DDT was identified as an ECOPC and carried forward into risk characterization.

#### 4.7 Lithium

Lithium had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. The lines of evidence used to determine if lithium should be retained as an ECOPC are summarized below.

##### 4.7.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for lithium to have been released into RFETS soil because of the moderate lithium metal inventory and presence of lithium in waste generated during former operations. However, these historical sources are remote from LWNEU.

#### **4.7.2 Evaluation of Spatial Trends**

##### ***Surface Soil (non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the analysis of spatial trends for surface soil indicates that lithium concentrations in surface soil reflect variations in naturally occurring lithium.

#### **4.7.3 Pattern Recognition**

##### ***Surface Soil (Non-PMJM)***

The probability plot for the natural log-transformed data set for lithium in surface soil within LWNEU (Figure A3.4.7) may represent a single background population. However there are insufficient samples containing more than 12 mg/kg lithium concentrations to document that the background population extends above 12 mg/kg. Only two samples (04F1248-002 and 02D0644-004) contain lithium concentrations above 12 mg/kg (13.1 and 16.0 mg/kg, respectively).

#### **4.7.4 Comparison to RFETS Background and Other Background Data Sets**

Lithium was detected in 100 percent of the 22 surface soil samples collected at the LWNEU and range from 4.80 to 16.0 mg/kg, with a mean concentration of 9.86 and a standard deviation of 2.54 mg/kg (Table A3.2.6). Background concentrations of lithium range from 4.80 to 11.6 mg/kg, with a mean of 7.66 mg/kg and a standard deviation of 1.89 mg/kg (Table A3.2.6). There is overlapping between the LWNEU data set and the site background data set indicating that the lithium concentrations within LWNEU represent natural variations in soil.

The reported range for lithium in surface soils in Colorado and the bordering states is 5 to 130 mg/kg, with an arithmetic mean of 25.3 mg/kg and a standard deviation of 14.4 mg/kg (Table A3.4.1). Lithium concentrations reported in surface soil samples at the LWNEU (4.80 to 16.0 mg/kg) are well within this range.

#### **4.7.5 Risk Potential for Plants and Wildlife**

##### ***Surface Soil (Non-PMJM)***

The lithium MDC (16 mg/kg) exceeds the NOAEL ESL for only one receptor, terrestrial plants (2 mg/kg), which is lower than the minimum detection of lithium in background surface soil. None of the NOAEL ESLs for mammalian receptors (both non-PMJM and PMJM) are exceeded by the LWNEU surface soil lithium MDC. NOAEL ESLs were not available for avian receptors due to lack of toxicity information. The authors of the document from which the lithium NOAEL ESL was selected (Efroymson et al. 1997b) placed a low confidence rating on the value. Other studies reported in Efroymson et al. (1997b) cited no observed adverse effects at 25 mg/kg, which is greater than the MDC. Lithium concentrations greater than the background in the LWNEU are most likely due to local variations in natural sources and are below available ESLs for vertebrate

receptors. Only a highly conservative and uncertain ESL for terrestrial plants was exceeded. It is unlikely that lithium poses a risk potential to non-PMJM and PMJM receptors in the LWNEU.

#### **4.7.6 Conclusion**

Process knowledge indicates lithium was present in the metals inventory but unlikely to be found in soils at LWNEU as a result of historical site-related activities. The weight of evidence presented above shows that lithium concentrations in LWNEU surface soil (non-PMJM receptors) have a spatial distribution and single data population indicative of naturally occurring lithium and are well within regional background levels. Review of the potential risk issues involved with lithium in surface soils indicates that risks to ecological receptors are highly unlikely and agrees with the other lines of evidence that it is not necessary to carry lithium forward in the ECOPC identification process. Lithium is, therefore, not considered an ECOPC in surface soil for the LWNEU and is not further evaluated quantitatively.

#### **4.8 Molybdenum**

Molybdenum had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. The lines of evidence used to determine whether molybdenum should be retained as an ECOPC are summarized below.

##### **4.8.1 Summary of Process Knowledge**

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on process knowledge, molybdenum is unlikely to be present in RFETS soil as a result of historical site-related activities.

##### **4.8.2 Evaluation of Spatial Trends**

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on spatial distribution trend analysis, molybdenum concentrations in surface soil in PMJM habitat for the LWNEU reflect variations in naturally occurring molybdenum.

##### **4.8.3 Pattern Recognition**

###### ***Surface Soil (Non-PMJM)***

The probability plot for the natural log-transformed data set for molybdenum in surface soil for non-PMJM receptors within LWNEU (Figure A3.4.8) indicates the presence of a single background population. There is a gap between 1.09 mg/kg and the cluster of three highest molybdenum concentrations with concentrations between 2.5 and 2.7 mg/kg, but the average of the three samples coincides with the background population line projected from the lower molybdenum concentrations.

#### 4.8.4 Comparison to RFETS Background and Other Background Data Sets

Background samples were all below detection limits. Molybdenum was detected in 15 of the 22 surface soil samples collected in the LWNEU. Molybdenum concentrations in surface soil for non-PMJM receptors within LWNEU range from 0.202 to 5.30 mg/kg, with a mean of 0.967 mg/kg and a standard deviation of 1.26 mg/kg (Table A3.2.6). The reported background concentrations for molybdenum in surface soil of Colorado and bordering states range from 3.0 to 7.0 mg/kg, with a mean of 1.59 mg/kg and a standard deviation of 0.522 mg/kg (Table A3.4.1) (Shacklette and Boerngen 1984). The maximum detection of 5.3 mg/kg was collected with three other samples that were all nondetects and had detection limits of 5.0 to 5.4 mg/kg. Additionally, the detected value of 5.3 mg/kg is both B- and J-qualified, indicating that it was reported at a value below the detection limit. All other detected values ranged from 0.202 to 1.09 mg/kg, similar to the background nondetected data. Additionally, all detected values were also B-qualified and are suspect. Detected concentrations of molybdenum in surface soil samples at the LWNEU are well within lower range of background concentrations of molybdenum in surface soils of Colorado and bordering states.

#### 4.8.5 Risk Potential for Plants and Wildlife

##### *Surface Soil (Non-PMJM)*

The UTL for molybdenum in the LWNEU (5.3 mg/kg) exceeds the NOAEL ESL for two receptor groups, terrestrial plants (2.0 mg/kg), and deer mouse insectivore (1.90 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 6.97 to 275 mg/kg. Only the ESL for terrestrial plants is within the range of background concentrations. None of the remaining ESLs are within the range of background concentrations and are not likely to be overly conservative for use in screening level risk assessments.

#### 4.8.6 Conclusion

The weight of evidence presented above shows that molybdenum concentrations in LWNEU surface soil for non-PMJM receptors are unlikely to be a result of historical site-related activities based on process knowledge, and that the spatial distribution trend and the presence of a single data population are indicative of naturally occurring molybdenum. Based on the information reviewed as part of the professional judgment process, molybdenum is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

#### 4.9 Nickel

Nickel had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. In addition, nickel was also determined to be an ECOI in surface soil for PMJM receptors. The lines of evidence used to determine whether nickel should be retained as an ECOPC are summarized below.

#### **4.9.1 Summary of Process Knowledge**

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on process knowledge, indicates a potential for nickel to have been released into RFETS soil because of the moderate nickel metal inventory and presence of nickel in waste generated during former operations. However, these historical sources are remote from the LWNEU. Therefore, nickel is unlikely to be present in LWNEU soil as a result of historical site-related activities.

#### **4.9.2 Evaluation of Spatial Trends**

##### ***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on spatial distribution trend analysis, nickel concentrations in surface soil for the LWNEU reflect variations in naturally occurring nickel.

##### ***Surface Soil (PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on spatial distribution trend analysis, nickel concentrations in surface soil for PMJM receptors for the LWNEU reflect variations in naturally occurring nickel.

#### **4.9.3 Pattern Recognition**

##### ***Surface Soil (Non-PMJM and PMJM)***

The probability plot for the natural log-transformed data set for nickel in surface soil in LWNEU (Figure A3.4.9) nickel suggests the presence of a single background population.

#### **4.9.4 Comparison to RFETS Background and Other Background Data Sets**

##### ***Surface Soil (Non-PMJM)***

Nickel was detected in each of the 22 surface soil non-PMJM samples collected in the LWNEU. Nickel concentrations in surface soil at the LWNEU range from 7.0 to 22.0 mg/kg, with a mean concentration of 14.0 mg/kg and a standard deviation of 3.02 mg/kg (Table A3.2.6). Background concentrations of nickel range from 3.8 to 14.0 mg/kg, with a mean of 9.6 mg/kg and a standard deviation of 2.59 mg/kg (Table A3.2.6).

The reported background concentrations for nickel in surface soil of Colorado and bordering states range from 5.0 to 700.0 mg/kg (Table A3.4.1), with an arithmetic mean of 18.8 mg/kg and a standard deviation of 39.8 mg/kg (Shacklette and Boerngen 1984). Nickel concentrations reported in surface soil samples at the LWNEU (7.0 to 22.0 mg/kg) are well within the regional background concentration range.

### ***Surface Soil (PMJM)***

Nickel was detected in each of the nine surface soil samples collected at the LWNEU PMJM habitats. Nickel concentrations in surface soil (PMJM) samples within LWNEU range from 11.3 to 18.2 mg/kg, with a mean concentration of 15.3 mg/kg and a standard deviation of 2.05 mg/kg (Table A3.2.8). Background concentrations of nickel range from 3.8 to 14.0 mg/kg, with a mean of 9.6 mg/kg and a standard deviation of 2.59 mg/kg (Table A3.2.8). In addition, the nickel concentrations in LWNEU surface soil samples are in the lower range of regional background nickel concentrations in surface soil in Colorado and bordering states (Table A3.4.1).

## **4.9.5 Risk Potential for Plants and Wildlife**

### ***Surface Soil (Non-PMJM)***

The UTL for nickel in the LWNEU (19.7 mg/kg) exceeds the NOAEL ESL for six receptor groups, insectivorous mourning dove (1.24 mg/kg), American kestrel (13.0 mg/kg), herbivorous deer mouse (16.0 mg/kg), insectivorous deer mouse (0.43 mg/kg), coyote generalist (6.02 mg/kg), and insectivorous coyote (1.86 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 30 to 200 mg/kg. All of the ESLs exceeded by the UTL (except the herbivorous deer mouse) are lower than the MDC in background surface soils. Since risks are not typically expected at background concentrations, these ESLs may be overly conservative.

### ***Surface Soil (PMJM)***

The MDC for nickel in the LWNEU (18.2 mg/kg) exceeds the NOAEL ESL for PMJM (0.51 mg/kg). However, the probability plots indicate the presence of a single background population. Therefore, although the MDC and UTL for nickel exceed the PMJM ESL, the ecological risks to this receptor group within LWNEU is expected to be similar to risks associated with naturally occurring nickel concentrations site wide.

## **4.9.6 Conclusion**

The weight of evidence presented above shows that nickel concentrations in LWNEU surface soil for non-PMJM and PMJM receptors represent a single data population indicative of naturally occurring nickel. Based on the information reviewed as part of the professional judgment process, nickel is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

## **4.10 Radium-228**

A background comparison analysis could not be performed for radium-228 in surface soil/surface sediment in the LWNEU because there was a single sample location within the EU. However, since the single radium-228 activity (considered MDC) and its UCL exceeded the PRG, radium-228 was carried forward to the professional judgment step per

the CRA methodology. The lines of evidence used to determine if radium-228 should be retained as a COC are summarized below.

#### **4.10.1 Summary of Process Knowledge**

The potential for radium-228 to be a COC in the LWNEU is very low since it was not used at RFETS. The ChemRisk Task 1 Report did not identify radium-228 as a radionuclide used at RFETS (CDH 1991a) and no radium-228 waste was reported to have been generated.

#### **4.10.2 Evaluation of Spatial Trends**

##### ***Surface Soil/Surface Sediment***

Figure A3.4.10 shows the single location where radium-228 was sampled within LWNEU. The single radium-228 activity of 0.930 pCi/g exceeded the PRG of 0.111 pCi/g. This radium-228 activity is similar to activities throughout the site and is less than the site background MDC of 4.10 pCi/g.

#### **4.10.3 Pattern Recognition**

##### ***Surface Soil/Surface Sediment***

A probability plot for radium-228 activity could not be generated because there was a single sample result for the LWNEU data set.

#### **4.10.4 Comparison to RFETS Background and Other Background Data Sets**

There was a single sample result for radium-228 in surface soil/surface sediment at LWNEU and, therefore, a statistical background comparison could not be performed. The radium-228 surface soil/surface sediment of 0.930 pCi/g does not exceed the site background MDC of 4.10 pCi/g. The site background activities for radium-228 in surface soil/ surface sediment range from 0.200 pCi/g to 4.10 pCi/g, with a mean of 1.60 pCi/g and a standard deviation of 0.799 pCi/g (Table A3.2.2). Therefore, the activity of radium-228 in surface soil/surface sediment at LWNEU is well within site background activities.

#### **4.10.5 Risk Potential for HHRA**

##### ***Surface Soil/Surface Sediment***

The radium-228 MDC for surface soil/surface sediment is 0.930 pCi/g and the PRG is 0.111 pCi/g. Site background activities range from 0.200 to 4.10 pCi/g, which indicates that all site background activities for radium-228 exceed the PRG. This suggests that the radium-228 PRG of 0.111 pCi/g is very conservative and based on an excess carcinogenic risk of  $1\text{E-}06$ , therefore, the risk to human health is well within the NCP risk range of  $10^{-6}$  to  $10^{-4}$ . Furthermore, because radium-228 activities in the LWNEU

appear to represent naturally occurring and because radium-228 was not used at the site, this risk is not likely associated with any releases from RFETS.

#### **4.10.6 Conclusion**

The weight of evidence presented above shows that the single radium-228 activities in surface soil/surface sediment in the LWNEU is not a result of RFETS activities, but rather representative of naturally occurring activities. There is no evidence of a release from potential sources inside or outside the LWNEU that would impact radium-228 activities in surface soil/surface sediment. However, radium-228 activities in surface soil/surface sediment across RFETS, including the sample collected in LWNEU, are above the PRG. However, the radium-228 activity in surface soil/surface sediment sample at the LWNEU is much lower than the site background MDC. Radium-228 was not used or generated at RFETS and is, therefore, not considered a COC in surface soil/surface sediment for the LWNEU and not further evaluated quantitatively.

#### **4.11 Selenium**

Selenium had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. The lines of evidence used to determine whether selenium should be retained as an ECOPC are summarized below.

##### **4.11.1 Summary of Process Knowledge**

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on process knowledge, selenium is unlikely to be present in RFETS soil as a result of historical site-related activities.

##### **4.11.2 Evaluation of Spatial Trends**

###### ***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, a spatial concentration trend for selenium in surface soil at RFETS is not apparent. Therefore, based on this line of evidence, selenium concentrations in surface soil reflect variations in naturally occurring selenium.

##### **4.11.3 Pattern Recognition**

###### ***Surface Soil (Non-PMJM)***

The probability plot for the natural log-transformed data set for selenium in surface soil for non-PMJM receptors within LWNEU (Figure A3.4.11a) contains too many nondetected concentrations to be definitive. A total range from 0.16 to 0.78 mg/kg suggests the possibility that these samples represent a background population. Figure A3.4.11a is a probability plot assuming that all 21 selenium concentrations are detects

resulting in sample points deviating broadly from the trend line and a significant gap between 0.27 and 0.45 mg/kg selenium. However, Figure A3.4.11b is a plot of the two detected selenium concentrations on a probability scale. Clearly there are too few detected selenium concentrations to estimate a background population.

#### **4.11.4 Comparison to RFETS Background and Other Background Data Sets**

##### ***Surface Soil (Non-PMJM)***

Selenium was detected in only two of the 22 surface soil samples collected in the LWNEU. Selenium concentrations in surface soil at the LWNEU range from 0.660 to 0.780 mg/kg, with a mean concentration of 0.339 mg/kg and a standard deviation of 0.181 mg/kg (Table A3.2.6). Background concentrations of selenium range from 0.680 to 1.40 mg/kg, with a mean of 0.628 mg/kg and a standard deviation of 0.305 mg/kg (Table A3.2.6). Given that selenium was detected at only two locations out of the 22 sampling locations within LWNEU, a statistical background analysis could not be performed. However, the two detected concentrations of selenium in surface soil at LWNEU are within site background concentrations and do not exceed the site background MDC.

Table A3.4.1 shows that the reported background concentrations for selenium in surface soil of Colorado and bordering states range from 0.10 to 4.32.0 mg/kg, with a mean of 0.349 mg/kg and a standard deviation of 0.415 mg/kg (Shacklette and Boerngen 1984). The surface soil selenium concentrations detected at two out of 22 sampling locations at the LWNEU (0.660 and 0.780 mg/kg) are well within the site background concentrations as well as within the lower range of the regional background concentrations.

#### **4.11.5 Risk Potential for Plants and Wildlife**

##### ***Surface Soil (Non-PMJM)***

The UTL for in the LWNEU (0.780 mg/kg) exceeds only one NOAEL ESL group receptor, the insectivorous deer mouse (0.750 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 0.87 to 70.0 mg/kg. The selenium MDC and UTL (0.780 mg/kg) are approximately half as much as the site background MDC (1.40 mg/kg) indicating that the selenium in the LWNEU is naturally occurring.

#### **4.11.6 Conclusion**

The weight of evidence presented above shows that selenium concentrations in LWNEU surface soil for non-PMJM receptors are indicative of naturally occurring selenium. Based on the information reviewed as part of the professional judgment process, selenium is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

## 4.12 Tin

Tin had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. The lines of evidence used to determine whether tin should be retained as an ECOPC are summarized below.

### 4.12.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on process knowledge, indicates the potential for tin to have released into RFETs soil because of the moderate tin metal inventory. However, these historical sources are remote from the LWNEU. Therefore, tin is unlikely to be present in LWNEU soil as a result of historical site-related activities.

### 4.12.2 Evaluation of Spatial Trends

#### *Surface Soil (Non-PMJM)*

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the results of a spatial concentration trend analysis for tin concentrations in surface soil indicates that tin concentrations in surface soil for the LWNEU reflect variations in naturally occurring tin.

### 4.12.3 Pattern Recognition

#### *Surface Soil (Non-PMJM)*

The probability plot for the natural log-transformed data set for tin in surface soil for non-PMJM receptors within LWNEU (Figure A3.4.12) that includes nondetect concentrations is inconclusive. The majority of the 22 samples form an apparent background population ranging from 0.29 to 1.25 mg/kg with four anomalous samples (SS20019WC, SS20020WC, SS20025WC and SS20032WC) with significantly higher concentrations (12.6, 13.0, 13.55 and 93.3 mg/kg, respectively). Three of those samples are nondetect values. The probability plots are inconclusive with regard to determining a background population.

### 4.12.4 Comparison to RFETS Background and Other Background Data Sets

#### *Surface Soil (Non-PMJM)*

Tin was below detection limits for all background data. Detection limits ranged from 2.7 to 5.8 mg/kg. Tin was detected in nine of the 22 surface soil samples collected in the LWNEU. Tin concentrations in surface soil samples at the LWNEU range from 0.289 to 93 mg/kg, with a mean concentration of 6.56 mg/kg and a standard deviation of 19.9 mg/kg (Table A3.2.6). The reported background concentrations for tin in surface soil of Colorado and bordering states range from 0.12 to 5.0 mg/kg, with a mean concentration of 1.15 mg/kg and a standard deviation of 0.772 mg/kg (Table A3.4.1)

(Shacklette and Boerngen 1984). One location exists in the LWNEU that is above the site background MDC. However, this single sample of 93 mg/kg is actually below the reporting limit of 100 mg/kg. Other than the MDC (which was sampled in 1993), detected concentrations of tin in surface soil samples at the LWNEU are well within the background tin concentrations in surface soils in Colorado and bordering states and within the range of nondetected values for site background.

#### **4.12.5 Risk Potential for Plants and Wildlife**

##### ***Surface Soil (Non-PMJM)***

The UTL of tin in the LWNEU (93.3 mg/kg) exceeds the NOAEL ESL for ten receptor groups, terrestrial plants (50 mg/kg), herbivorous mourning dove (26 mg/kg), insectivorous mourning dove (2.9 mg/kg), American kestrel (19 mg/kg), herbivorous deer mouse (45 mg/kg), insectivorous deer mouse (3.77 mg/kg), prairie dog (81 mg/kg), carnivorous coyote (70 mg/kg), insectivorous coyote (16 mg/kg) and coyote generalist (36 mg/kg). However, the next highest detected concentration of 0.638 mg/kg does not exceed any of these NOAEL ESLs. The NOAEL ESLs are modeled values based on a variety of exposure factors that are assumed to be similar to conditions at the site based on available information. In addition, the TRVs used in the derivation of the NOAEL ESLs may also have associated uncertainties, and the resulting NOAEL ESLs may be over-protective of some receptor groups. In addition, tin concentrations are most likely due to local variation in natural sources. No known sources of tin contamination are found in the LWNEU.

#### **4.12.6 Conclusion**

The weight of evidence presented above shows that tin concentrations in LWNEU surface soil for non-PMJM receptors are not likely to be a result of historical site-related activities based on process knowledge, the spatial distribution trend and comparison of data sets. In addition, only one sample exceeded the NOAEL ESLs and, thus, tin is unlikely to cause risk to ecological populations. Tin is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

#### **4.13 Vanadium**

Vanadium had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. The lines of evidence used to determine whether vanadium should be retained as an ECOPC are summarized below.

##### **4.13.1 Summary of Process Knowledge**

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on process knowledge, vanadium is unlikely to be present in RFETS soil as a result of historical site-related activities.

#### **4.13.2 Evaluation of Spatial Trends**

##### ***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the results of a spatial concentration trend analysis for vanadium concentrations in surface soil at the LWNEU reflect variations in naturally occurring vanadium.

#### **4.13.3 Pattern Recognition**

##### ***Surface Soil (Non-PMJM)***

The probability plot for the natural log-transformed data set for vanadium in surface soil for non-PMJM receptors within LWNEU (Figure A3.4.13) indicates the presence of a single background population.

#### **4.13.4 Comparison to RFETS Background and Other Background Data Sets**

##### ***Surface Soil (Non-PMJM)***

Vanadium was detected in each of the 22 surface soil samples collected in the LWNEU. Vanadium concentrations in surface soil at the LWNEU range from 20.9 to 52.0 mg/kg, with a mean concentration of 34.4 mg/kg and a standard deviation of 8.11 mg/kg (Table A3.2.6). Background concentrations of vanadium range from 10.8 to 45.8 mg/kg, with a mean of 27.7 mg/kg and a standard deviation of 7.68 mg/kg (Table A3.2.6).

Vanadium concentrations at the LWNEU are well within the range of reported literature values. The reported background concentrations for vanadium in surface soil of Colorado and bordering states range from 7.0 to 300.0 mg/kg (Table A3.4.1), with a mean of 73.0 mg/kg and a standard deviation of 41.7 mg/kg (Shacklette and Boerngen 1984).

Vanadium concentrations reported in surface soil samples at the LWNEU (20.9 to 52.0 mg/kg) are well within the range of regional surface soil vanadium concentrations.

#### **4.13.5 Risk Potential for Plants and Wildlife**

##### ***Surface Soil (Non-PMJM)***

The UTL for vanadium in the LWNEU (49.7 mg/kg) exceeds the NOAEL ESL for two receptor groups, terrestrial plants (2 mg/kg), and the insectivorous deer mouse (30.0 mg/kg). Both of the ESLs are within the range of background concentrations. Since risks are not typically expected at background concentrations these ESLs are likely to be overly conservative. All other NOAEL ESLs were greater than the UTL and ranged from 64.0 to 1,514 mg/kg.

#### 4.13.6 Conclusion

The weight of evidence presented above shows that vanadium concentrations in LWNEU surface soil for non-PMJM receptors represent a single data population indicative of naturally occurring vanadium. Based on the information reviewed as part of the professional judgment process, vanadium is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

#### 4.14 Zinc

Zinc had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. The lines of evidence used to determine whether zinc should be retained as an ECOPC are summarized below.

##### 4.14.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on process knowledge, zinc is unlikely to be present in RFETS soil as a result of historical site-related activities.

##### 4.14.2 Evaluation of Spatial Trends

###### *Surface Soil (Non-PMJM)*

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the results of a spatial concentration trend analysis for zinc concentrations in surface soil for the LWNEU reflect variations in naturally occurring zinc.

##### 4.14.3 Pattern Recognition

###### *Surface Soil (Non-PMJM)*

The probability plot for the natural log-transformed data set for zinc in surface soil for non-PMJM receptors within LWNEU (Figure A3.4.14) indicates the presence of a single background population.

##### 4.14.4 Comparison to RFETS Background and Other Background Data Sets

###### *Surface Soil (Non-PMJM)*

Zinc was detected in each of the 22 surface soil samples collected in the LWNEU. Zinc concentrations collected at the LWNEU range from 43.0 to 77.5 mg/kg, with a mean concentration of 56.1 mg/kg and a standard deviation of 10.0 mg/kg (Table A3.2.6). Sitewide background concentrations of zinc range from 21.1 to 75.9 mg/kg, with a mean of 49.8 mg/kg and a standard deviation of 12.2 mg/kg (Table A3.2.6). The LWNEU zinc MDC for surface soil (77.5 mg/kg) was just slightly above the site background MDC of 75.9 mg/kg.

The reported range for zinc in surface soil of the of Colorado and bordering states range from 10.0 to 2,080 mg/kg, with a mean of 72.4 mg/kg and a standard deviation of 159.0 mg/kg (Table A3.4.1) (Shacklette and Boerngen 1984). Zinc concentrations reported in surface soil samples at the LWNEU (43.0 to 77.5 mg/kg) are well within this range.

#### **4.14.5 Risk Potential for Plants and Wildlife**

##### ***Surface Soil (Non-PMJM)***

The UTL for zinc in the LWNEU (75.0 mg/kg) exceeds the NOAEL ESL for three receptor groups, terrestrial plants (50 mg/kg), insectivorous mourning dove (0.65 mg/kg), and the insectivorous deer mouse (5.29 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 109 to 16,489 mg/kg. The mourning dove and deer mouse (insectivore) ESLs are both considerably lower than all zinc concentrations in background soils (75.9 mg/kg). Since risks are not typically expected at background concentrations, it is likely that these ESLs are overly conservative. The terrestrial plant ESL is approximately equal to the median background concentration, again indicating that it may be overly conservative for use in the risk assessment.

#### **4.14.6 Conclusion**

The weight of evidence presented above shows that zinc concentrations in LWNEU surface soil for non-PMJM receptors are not likely to be a result of historical site-related activities based on process knowledge, the spatial distribution trend, the presence of a single background population, and comparison of data sets. In addition, while zinc concentrations exceed several highly conservative ESLs, there is no indication that potential risks to ecological receptors from zinc are elevated. Zinc is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

## **5.0 REFERENCES**

CDH, 1991a. Colorado Department of Health Project Task 1 Report (Revised 1), Identification of Chemicals and Radionuclides Used at Rocky Flats. Prepared by ChemRisk. March.

CDH, 1991b. Colorado Department of Health Project Task 2, Selection of the Chemicals and Radionuclides of Concern. Prepared by ChemRisk. June. DOE, 2004a. Final Comprehensive Risk Assessment Work Plan and Methodology, Rocky Flats Environmental Technology Site, Golden, Colorado. September.

DOE, 1995. Final Geochemical Characterization of Background Surface Soils: Background Soils: Background Soils Characterization Program, U.S. Department of Energy, Rocky Flats Environmental Technology Site, Golden, Colorado.

DOE, 1996. Final Phase I RFI/RI Report. Woman Creek Priority Drainage-Operable Unit 5. Appendix N. Ecological Risk Assessment for Woman Creek and Walnut Creek Watersheds at the Rocky Flats Environmental Technology Site. Golden, Colorado.

DOE, 2005. Final Comprehensive Risk Assessment Work Plan and Methodology, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1. September.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten, 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants. 1997 Revision, ES/ER/TM-85/R3. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

EPA, 2003. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). OSWER 9285.7-55. Office of Solid Waste and Emergency Response. December.

EPA, 2005. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). Attachment 4-1 Update. Office of Solid Waste and Emergency Response, February.

Kabata-Pendias, A., and H. Pendias, 1992. Trace Elements in Soils and Plants. Second Edition. CRC Press, Boca Raton, Florida. 365 pp

Shacklette, H.T., and J.G. Boerngen, 1984. Element Concentrations in Soils and Other Surface Materials of the Contiguous United States. Professional Paper 1270. U.S. Geological Survey, Washington, D.C.

## **TABLES**

154

Table A3.2.1  
Statistical Distribution and Comparison to Background for LWNEU Surface Soil and Surface Sediment<sup>a</sup>

Analyte	Statistical Distribution Testing Results						Background Comparison Test		
	Background			LWNEU (excluding background samples)			Test	1 - p	Statistically Greater than Background?
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Arsenic	73	GAMMA	91.8	25	NORMAL	100	WRS	6.28E-05	Yes
Cesium-134	77	NON-PARAMETRIC	100	5	NON-PARAMETRIC	100	WRS	0.998	No
Cesium-137	105	NON-PARAMETRIC	100	10	NORMAL	100	WRS	0.638	No
Radium-228	40	GAMMA	100	1	0	100	WRS	N/A	N/A

<sup>a</sup> No background samples were collected from the LWNEU.

WRS = Wilcoxon Rank Sum.

N/A = Not applicable; site and/or background detection frequency less than 20%.

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

155

**Table A3.2.2**  
**Summary Statistics for LWNEU Surface Soil and Surface Sediment<sup>a,b</sup>**

Analyte	Units	Background					LWNEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation
Arsenic	mg/kg	73	0.270	9.60	3.42	2.55	25	2.20	9.40	5.45	1.56
Cesium-134	pCi/g	77	0.001	0.300	0.141	0.0657	5	0.002	0.110	0.0244	0.0479
Cesium-137	pCi/g	105	-0.0266	1.80	0.692	0.492	10	0.004	1.25	0.597	0.497
Radium-228	pCi/g	40	0.200	4.10	1.60	0.799	1	0.930	0.930	0.930	N/A

<sup>a</sup> No background samples were collected from the LWNEU.

<sup>b</sup> Statistics are computed using one-half the reported value for nondetects.

pCi/g: picocuries per gram.

N/A = Not available or not applicable.

15/2

**Table A3.2.3**  
**Statistical Distribution and Comparison to Background for LWNEU Subsurface Soil and Subsurface Sediment<sup>a</sup>**

Analyte	Statistical Distribution Testing Results						Background Comparison Test		
	Background			LWNEU (excluding background samples)					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Radium-228	31	GAMMA	100	4	NORMAL	100	WRS	0.944	No

<sup>a</sup> No background samples were collected from the LWNEU.

WRS =Wilcoxon Rank Sum.

Table A3.2.4  
Summary Statistics for LWNEU Subsurface Soil and Subsurface Sediment<sup>a, b</sup>

Analyte	Units	Background					LWNEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation
Radium-228	pCi/g	31	1	2.10	1.45	0.320	4	1.10	1.30	1	0.0856

<sup>a</sup> No background samples were collected from the LWNEU.

<sup>b</sup> Statistics are computed using one-half the reported value for nondetectes.

158

**Table A3.2.5**  
**Statistical Distribution and Comparison to Background for LWNEU Surface Soil Non-PMJM Receptors<sup>a</sup>**

Analyte	Units	Statistical Distribution Testing Results						Background Comparison Test		
		Background			LWNEU (excluding background samples)			Test	1. p	Statistically Greater Than Background?
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Aluminum	mg/kg	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.0296	Yes
Antimony	mg/kg	20	NONPARAMETRIC	0	14	NONPARAMETRIC	28.6	N/A	N/A	N/A
Arsenic	mg/kg	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.770	No
Barium	mg/kg	20	NORMAL	100	22	NORMAL	100	t-Test_N	5.06E-04	Yes
Boron	mg/kg	N/A	N/A	N/A	18	GAMMA	100	N/A	N/A	N/A
Cadmium	mg/kg	20	NONPARAMETRIC	65	22	NONPARAMETRIC	90.9	WRS	0.430	No
Chromium	mg/kg	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.00960	Yes
Copper	mg/kg	20	NONPARAMETRIC	100	22	NONPARAMETRIC	100	WRS	0.303	No
Lead	mg/kg	20	NORMAL	100	22	GAMMA	100	WRS	0.995	No
Lithium	mg/kg	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.00152	Yes
Manganese	mg/kg	20	NORMAL	100	22	NONPARAMETRIC	100	WRS	0.134	No
Mercury	mg/kg	20	NONPARAMETRIC	40	22	GAMMA	68.2	WRS	1.000	No
Molybdenum	mg/kg	20	NORMAL	0	22	GAMMA	68.2	N/A	N/A	N/A
Nickel	mg/kg	20	NORMAL	100	22	NORMAL	100	t-Test_N	4.59E-06	Yes
Selenium	mg/kg	20	NONPARAMETRIC	60	22	NONPARAMETRIC	9.09	N/A	N/A	N/A
Tin	mg/kg	20	NORMAL	0	22	NONPARAMETRIC	40.9	N/A	N/A	N/A
Vanadium	mg/kg	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.00451	Yes
Zinc	mg/kg	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.0371	Yes

<sup>a</sup> No background samples were collected from the LWNEU.

WRS = Wilcoxon Rank Sum.

t-Test\_N = Student's t-test using normal data.

N/A = Not applicable; site and/or background detection frequency less than 20%.

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

Table A3.2.6  
Summary Statistics for LWNEU Surface Soil Non-PMJM Receptors<sup>a,b</sup>

Analyte	Units	Background					LWNEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation
Aluminum	mg/kg	20	4,050	17,100	10,203	3,256	22	7,460	17,000	11,912	2,424
Antimony	mg/kg	20	N/A	N/A	0.279	0.0784	14	0.490	1.00	2.10	2.87
Arsenic	mg/kg	20	2.30	9.60	6.09	2.00	22	2.20	9.40	5.68	1.52
Barium	mg/kg	20	45.7	134	102	19.4	22	86.4	180	126	23.0
Boron	mg/kg	N/A	N/A	N/A	N/A	N/A	18	2.75	8.40	4.89	1.43
Cadmium	mg/kg	20	0.670	2.30	0.708	0.455	22	0.220	2.20	0.933	0.666
Chromium	mg/kg	20	5.50	16.9	11.2	2.78	22	7.92	21.0	13.4	2.97
Copper	mg/kg	20	5.20	16.0	13.0	2.58	22	5.00	17.5	13.4	2.68
Lead	mg/kg	20	8.60	53.3	33.5	10.5	22	13.3	50.9	25.8	10.1
Lithium	mg/kg	20	4.80	11.6	7.66	1.89	22	4.80	16.0	9.86	2.54
Manganese	mg/kg	20	129	357	237	63.9	22	170	1,110	301	193
Mercury	mg/kg	20	0.090	0.120	0.0715	0.0310	22	0.013	0.036	0.0312	0.0185
Molybdenum	mg/kg	20	N/A	N/A	0.573	0.184	22	0.202	5.30	0.967	1.26
Nickel	mg/kg	20	3.80	14.0	9.60	2.59	22	7.00	22.0	14.0	3.02
Selenium	mg/kg	20	0.680	1.40	0.628	0.305	22	0.660	0.780	0.339	0.181
Tin	mg/kg	20	N/A	N/A	2.06	0.410	22	0.289	93.3	6.56	19.9
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	22	20.9	52.0	34.4	8.11
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	22	43.0	77.5	56.1	10.0
4,4'-DDT	ug/kg	N/A	N/A	N/A	17.0	0.583	4	26.0	26.0	14.4	7.76

<sup>a</sup> No background samples were collected from the LWNEU.

<sup>b</sup> Statistics are computed using one-half the reported value for nondetects.

N/A = Not applicable.

**Table A3.2.7**  
**Statistical Distribution and Comparison to Background for Surface Soil in PMJM Habitat**

Analyte	Units	Statistical Distribution Testing Results						Background Comparison Test		
		Background			LWNEU (excluding background samples)			Test	1 - p	Statistically Greater Than Background?
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Arsenic	mg/kg	20	NORMAL	100	9	NONPARAMETRIC	100	WRS	0.738	No
Chromium	mg/kg	20	NORMAL	100	9	NORMAL	100	t-Test_N	0.067	Yes
Manganese	mg/kg	20	NORMAL	100	9	NORMAL	100	t-Test_N	0.118	No
Nickel	mg/kg	20	NORMAL	100	9	NORMAL	100	t-Test_N	1.88E-06	Yes
Vanadium	mg/kg	20	NORMAL	100	9	LOGNORMAL	100	WRS	0.144	No
Zinc	mg/kg	20	NORMAL	100	9	NORMAL	100	t-Test_N	0.156	No

WRS = Wilcoxon Rank Sum.

t-Test\_N = Student's t-test using normal data.

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

Table A3.2.8  
Summary Statistics For LWNEU Surface Soil in PMJM Habitat <sup>a,b</sup>

Analyte	Units	Background					LWNEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation
Arsenic	mg/kg	20	2.30	9.60	6.09	2.00	9	4.80	8.10	5.74	1.11
Chromium	mg/kg	20	5.50	16.9	11.2	2.78	9	7.92	21.0	13.1	3.68
Manganese	mg/kg	20	129	357	237	63.9	9	175	400	268	65.1
Nickel	mg/kg	20	3.80	14.0	9.60	2.59	9	11.3	18.2	15.3	2.05
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	9	21.5	52.0	31.6	8.72
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	9	44.3	64.7	54.3	7.04

<sup>a</sup> No background samples were collected from the LWNEU.

<sup>b</sup> Statistics are computed using one-half the reported value for nondetects.

162

**Table A3.2.9**  
**Statistical Distribution and Comparison to Background for Subsurface Soil\***

Analyte	Units	Summary Statistical for LWNEU Subsurface Soil*						Background Comparison Test		
		Background			LWNEU (excluding background samples)			Test	1 - p	Statistically Greater than Background?
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Arsenic	mg/kg	45	NONPARAMETRIC	93.3	14	NONPARAMETRIC	100	WRS	0.0936	Yes

\*No background samples were collected from the LWNEU.

WRS = Wilcoxon Rank Sum.

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

Table A3.2.10  
Summary Statistics For Subsurface Soil<sup>a,b</sup>

Analyte	Units	Background					LWNEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation
Arsenic	mg/kg	45	1.70	41.8	5.48	6.02	14	3.10	12.8	5.89	2.59

<sup>a</sup> No background samples were collected from the LWNEU.

<sup>b</sup> Statistics are computed using one-half the reported value for nondetects.

**Table A3.4.1**  
**Summary of Element Concentrations in Colorado and Bordering States Surface Soil<sup>a</sup>**

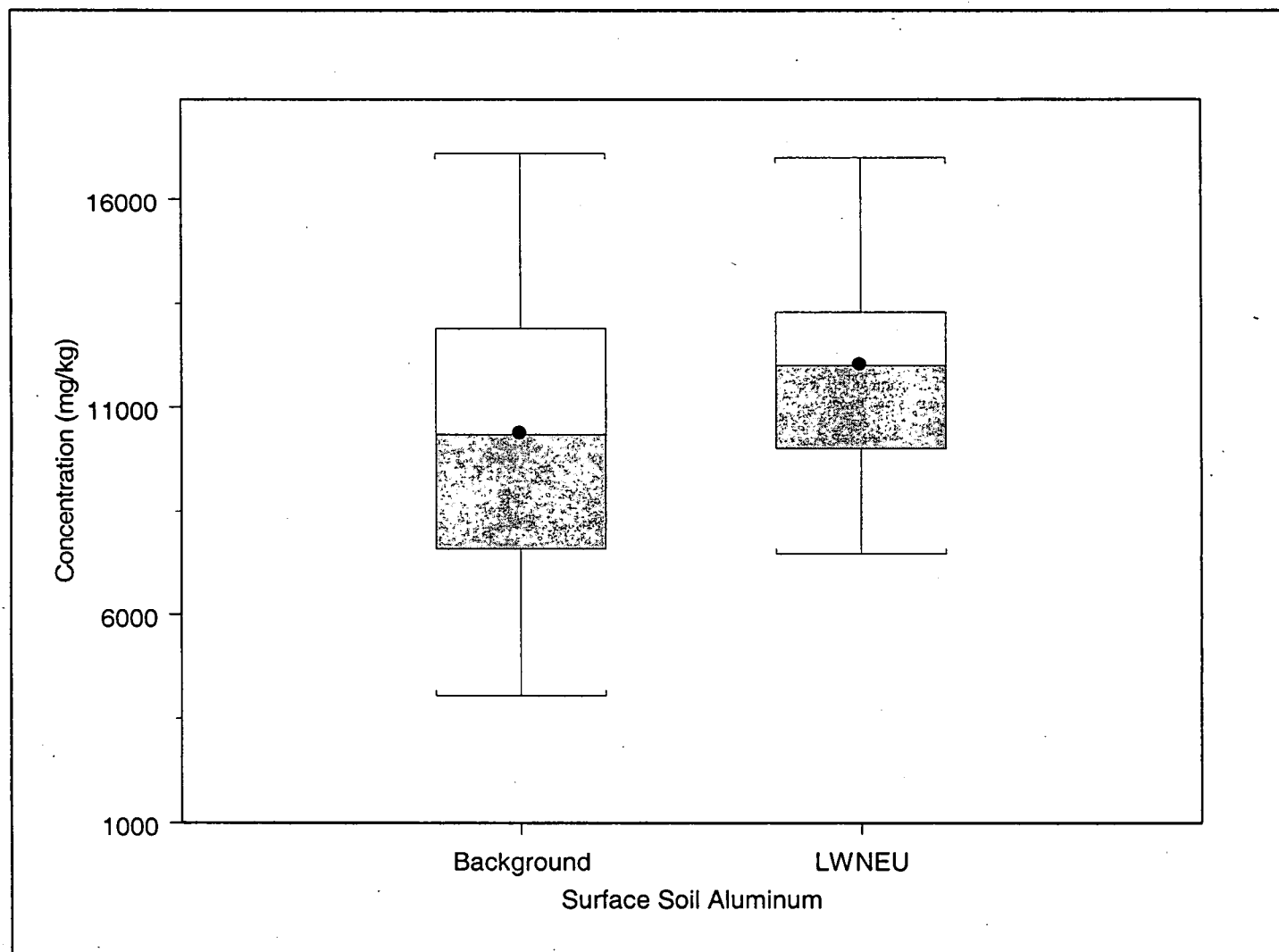
Analyte	Total Number of Results	Detection Frequency (%)	Range of Detected Values (mg/kg)	Average (mg/kg) <sup>b</sup>	Standard Deviation (mg/kg) <sup>b</sup>
Aluminum	303	100	5,000 - 100,000	50,800	23,500
Antimony	84	15.5	1.038 - 2.531	0.647	0.378
Arsenic	307	99.3	1.224 - 97	6.9	7.64
Barium	342	100	100 - 3,000	642	330
Beryllium	342	36	1 - 7	0.991	0.876
Boron	342	66.7	20 - 150	27.9	19.7
Bromine	85	50.6	0.5038 - 3.522	0.681	0.599
Calcium	342	100	0.055 - 32	3.09	4.13
Carbon	85	100	0.3 - 10	2.18	1.92
Cerium	291	16.2	150 - 300	90	38.4
Chromium	342	100	3 - 500	48.2	41
Cobalt	342	88.6	3 - 30	8.09	5.03
Copper	342	100	2 - 200	23.1	17.7
Fluorine	264	97.3	10 - 1,900	394	261
Gallium	340	99.1	5 - 50	18.3	8.9
Germanium	85	100	0.5777 - 2.146	1.18	0.316
Iodine	85	78.8	0.516 - 3.487	1.07	0.708
Iron	342	100	3,000 - 100,000	21,100	13,500
Lanthanum	341	66.3	30 - 200	39.8	28.8
Lead	342	92.7	10 - 700	24.8	41.5
Lithium	307	100	5 - 130	25.3	14.4
Magnesium	341	100	300 - 50,000	8,630	6,400
Manganese	342	100	70 - 2,000	414	272
Mercury	309	99	0.01 - 4.6	0.0768	0.276
Molybdenum	340	3.53	3 - 7	1.59	0.522
Neodymium	256	22.7	70 - 300	47.1	31.7
Nickel	342	96.5	5 - 700	18.8	39.8
Niobium	335	63.3	10 - 100	11.4	8.68
Phosphorus	249	100	40 - 4,497	399	397
Potassium	341	100	1,900 - 63,000	18,900	6,980
Rubidium	85	100	35 - 140	75.8	25
Scandium	342	85.1	5 - 30	8.64	4.69
Selenium	309	80.6	0.1023 - 4.3183	0.349	0.415
Silicon	85	100	149,340 - 413,260	302,000	61,500
Sodium	335	100	500 - 70,000	10,400	6,260
Strontium	342	100	10 - 2,000	243	212
Sulfur	85	16.5	816 - 47,760	1,250	5,300
Thallium	76	100	2.45 - 20.79	9.71	3.54
Tin	85	96.5	0.117 - 5.001	1.15	0.772
Titanium	342	100	500 - 7,000	2,290	1,350
Uranium	85	100	1.11 - 5.98	2.87	0.883
Vanadium	342	100	7 - 300	73	41.7
Ytterbium	330	99.1	1 - 20	3.33	2.06
Yttrium	342	98	10 - 150	26.9	18.1
Zinc	330	100	10 - 2,080	72.4	159
Zirconium	342	100	30 - 1,500	220	157

<sup>a</sup> Based on data from Shacklette and Boerngen 1984 for the states of Colorado, Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming.

<sup>b</sup> One-half the detection limit used as proxy value for nondetects in computation of the mean and standard deviation.

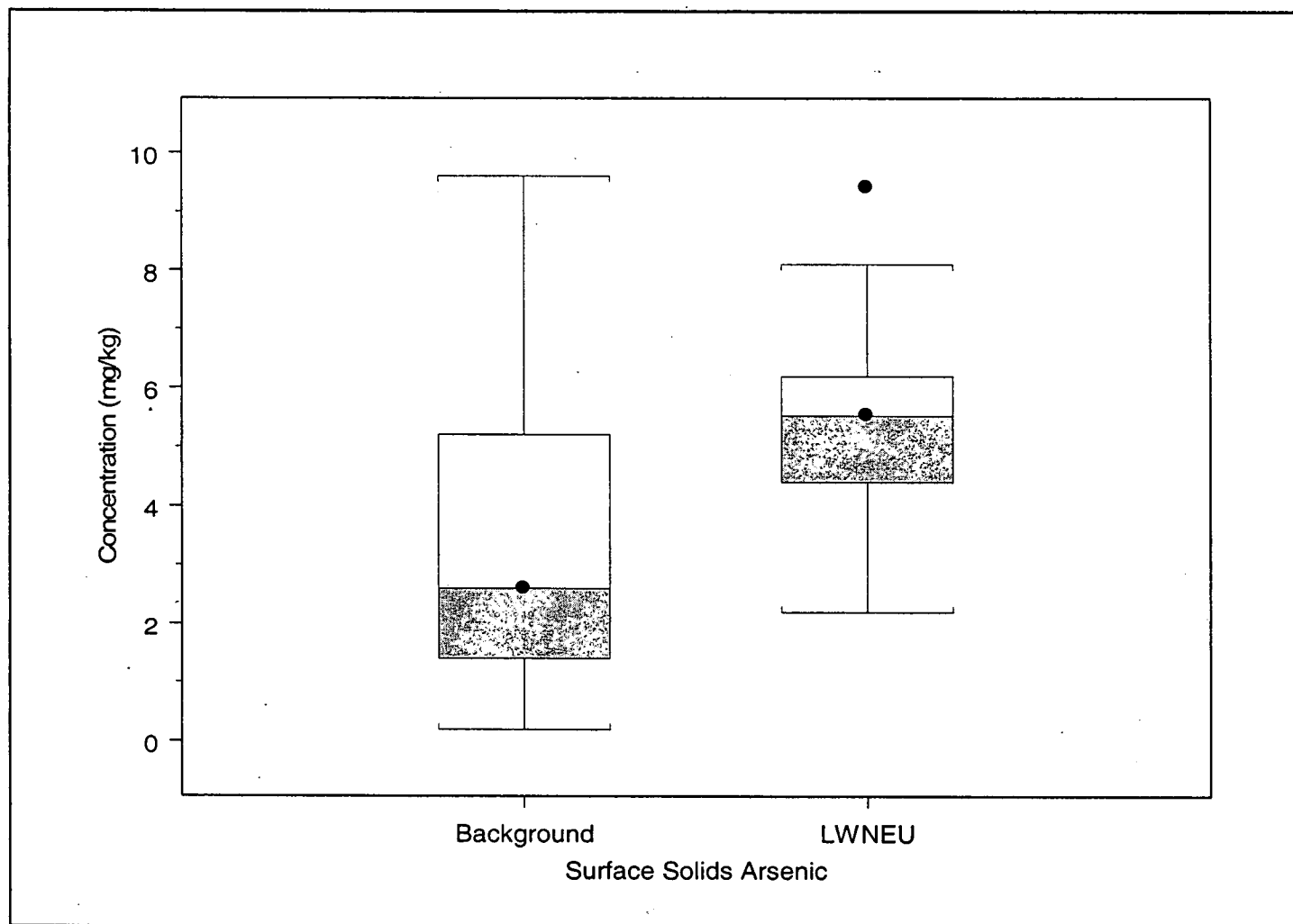
## **FIGURES**

Figure 3.2.1  
LWNEU Surface Soil Box Plots for Aluminum



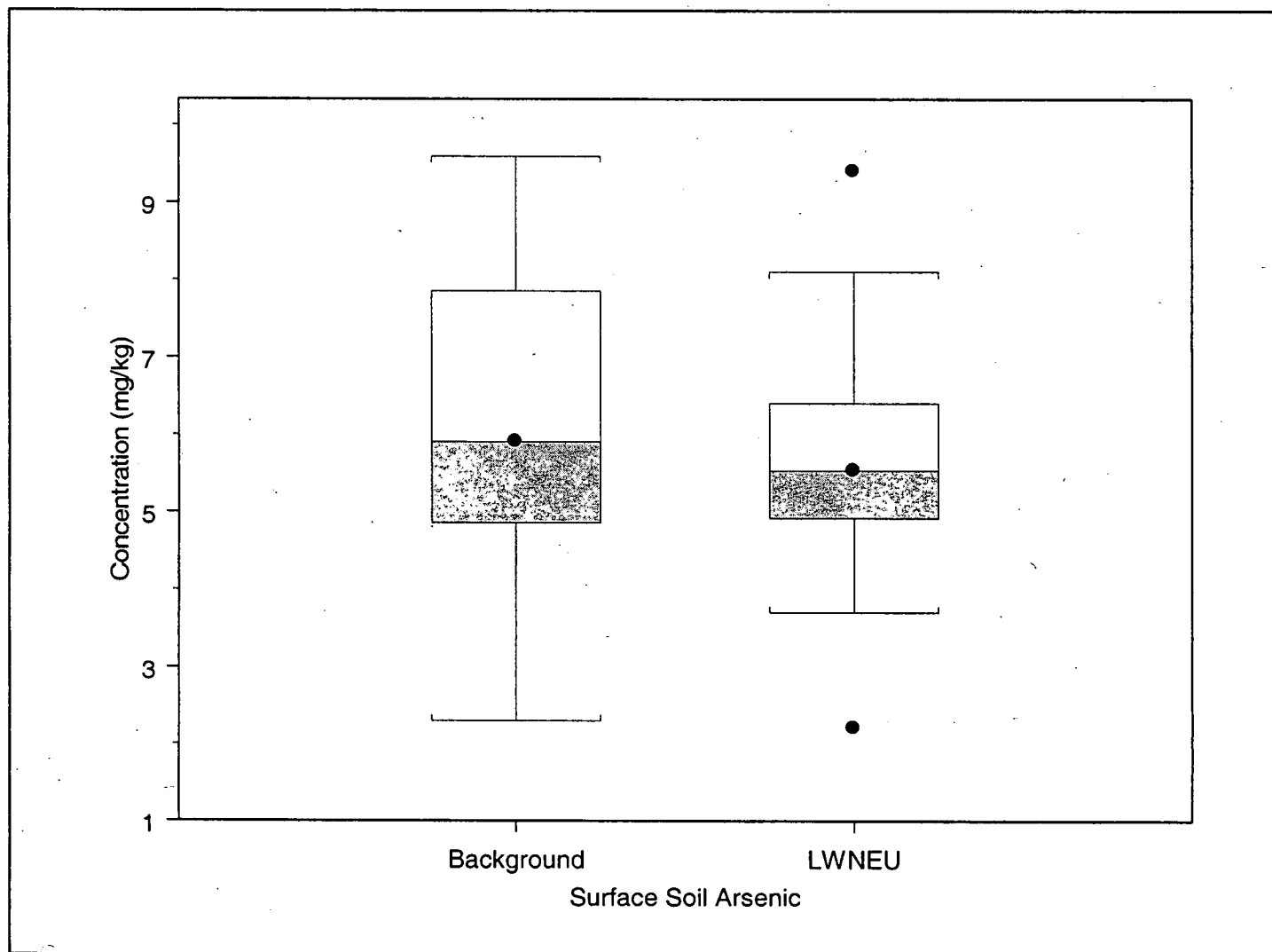
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.2  
LWNEU Surface Soil/Surface Sediment Box Plots for Arsenic



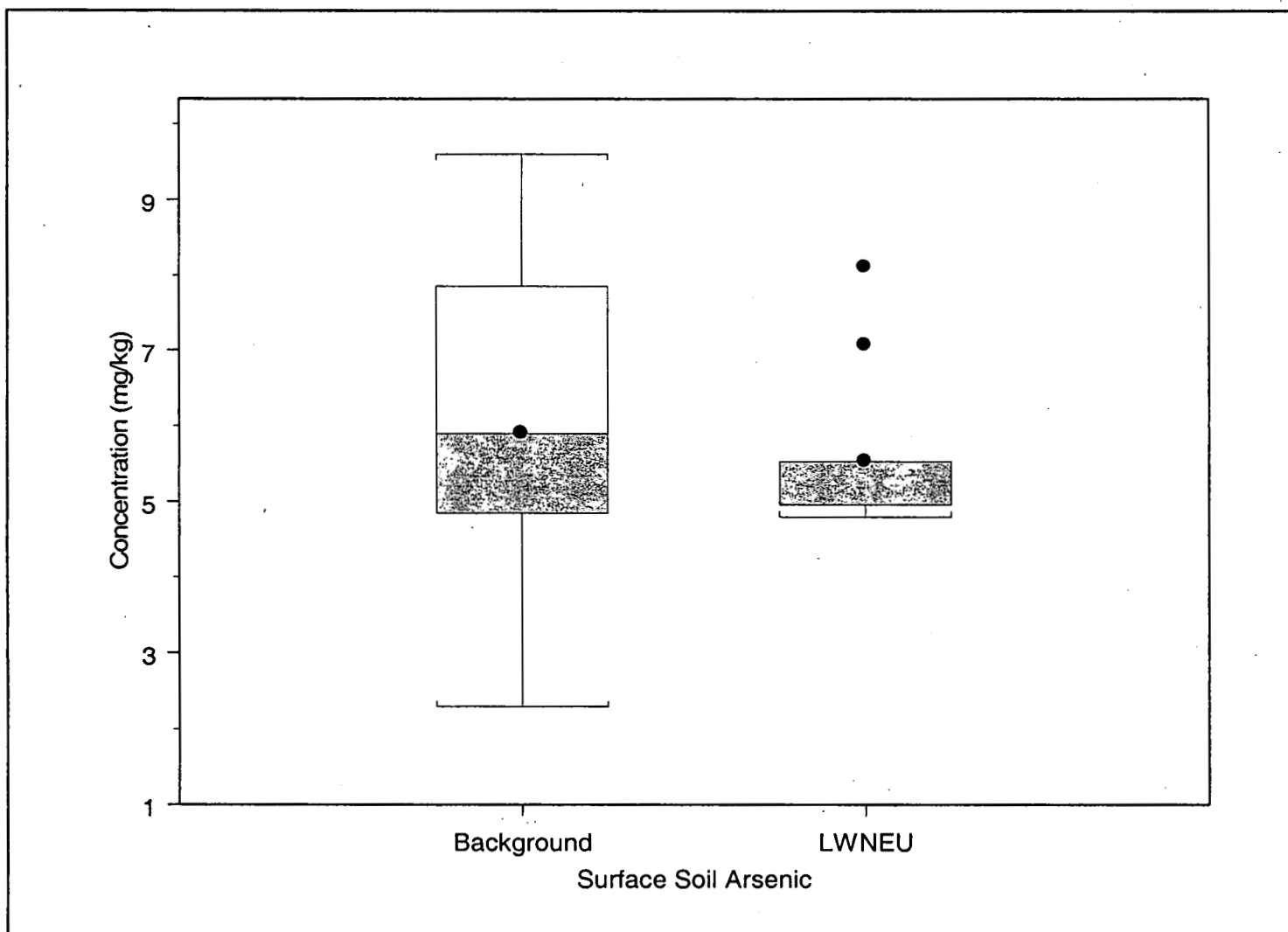
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.3  
LWNEU Surface Soil Box Plots for Arsenic



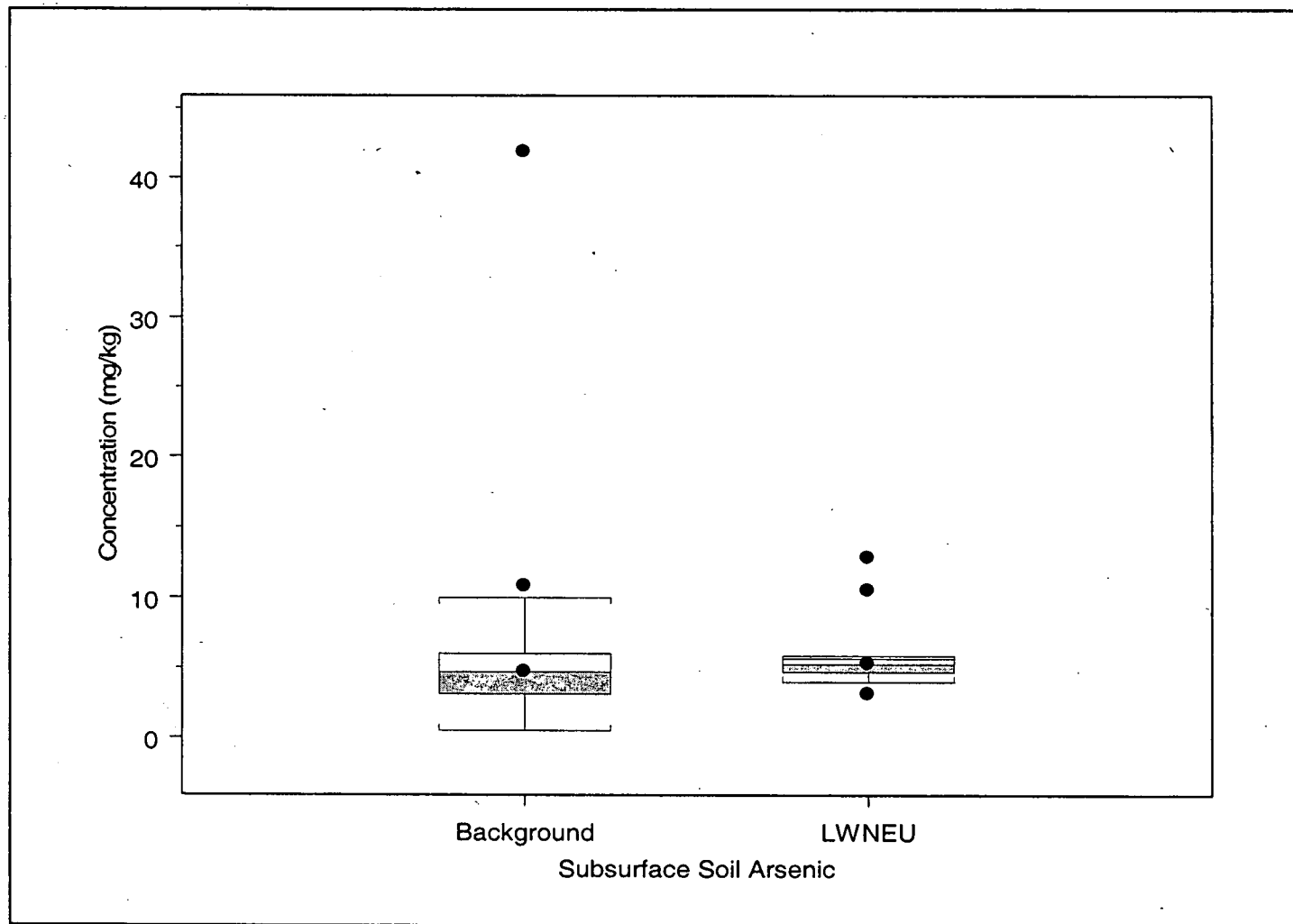
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 3.2.4  
LWNEU Surface Soil Box Plots for Arsenic (PMJM)



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

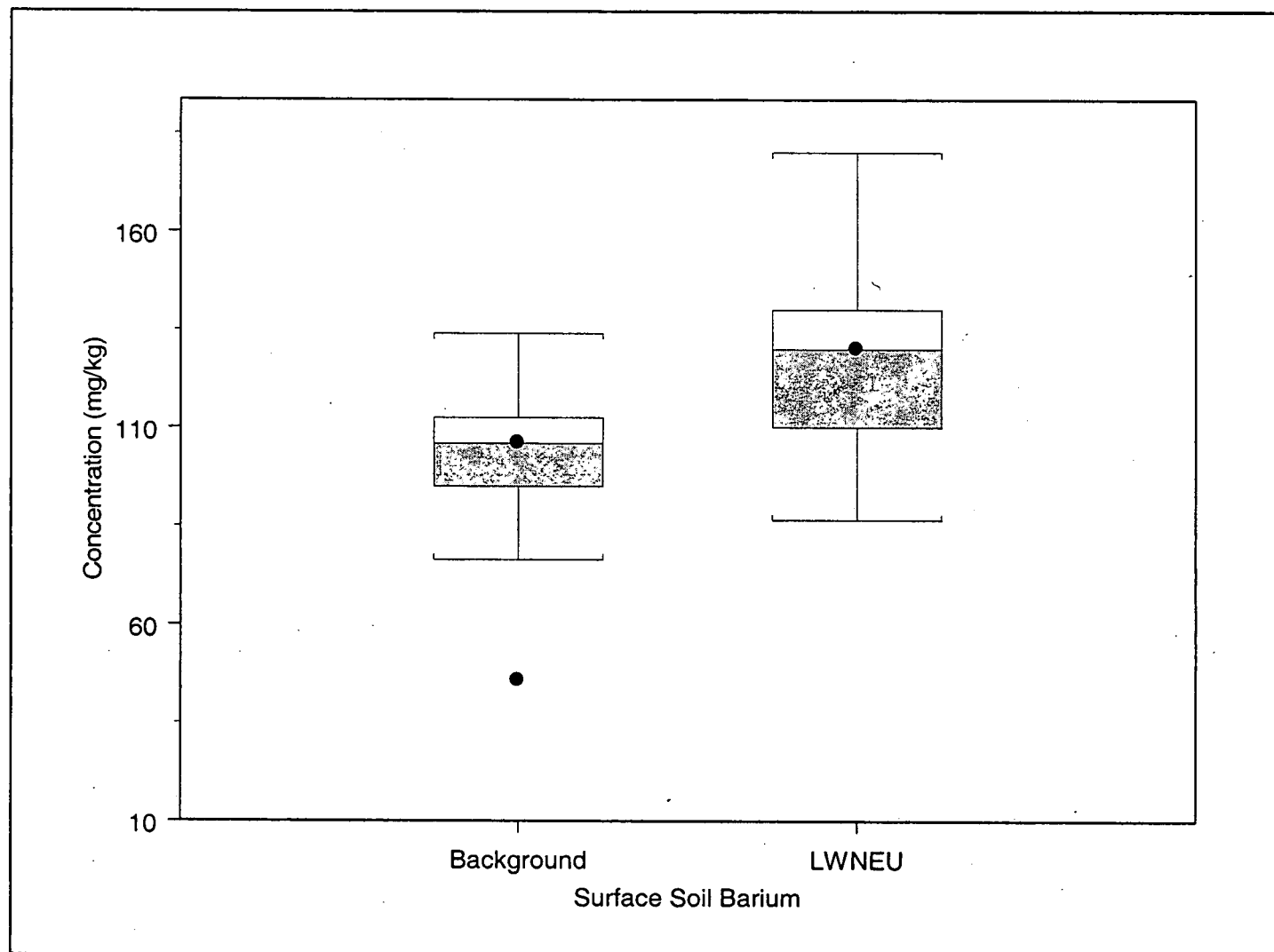
Figure A3.2.5  
LWNEU Subsurface Soil Box Plots for Arsenic



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

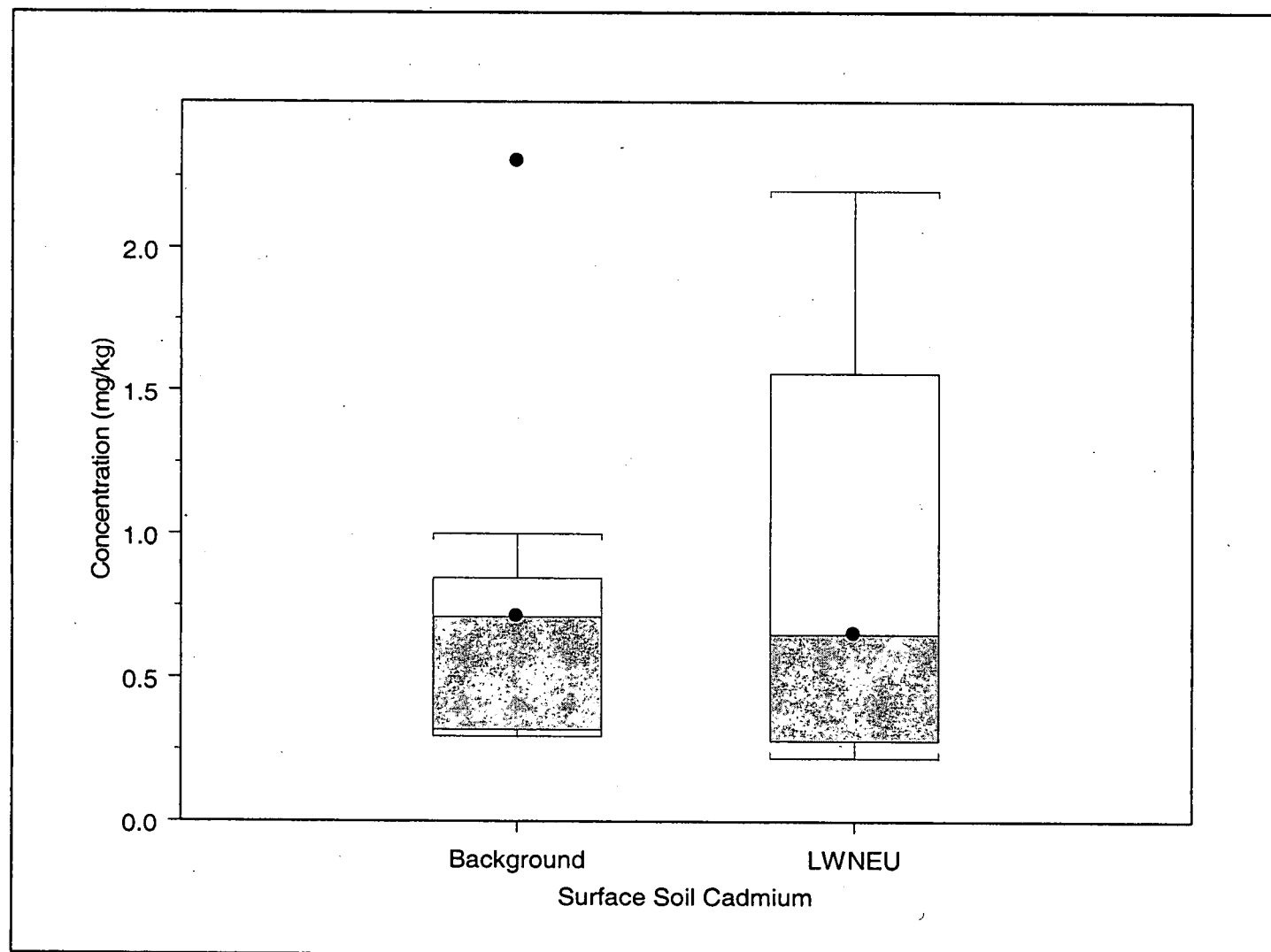
171

Figure A3.2.6  
LWNEU Surface Soil Box Plots for Barium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

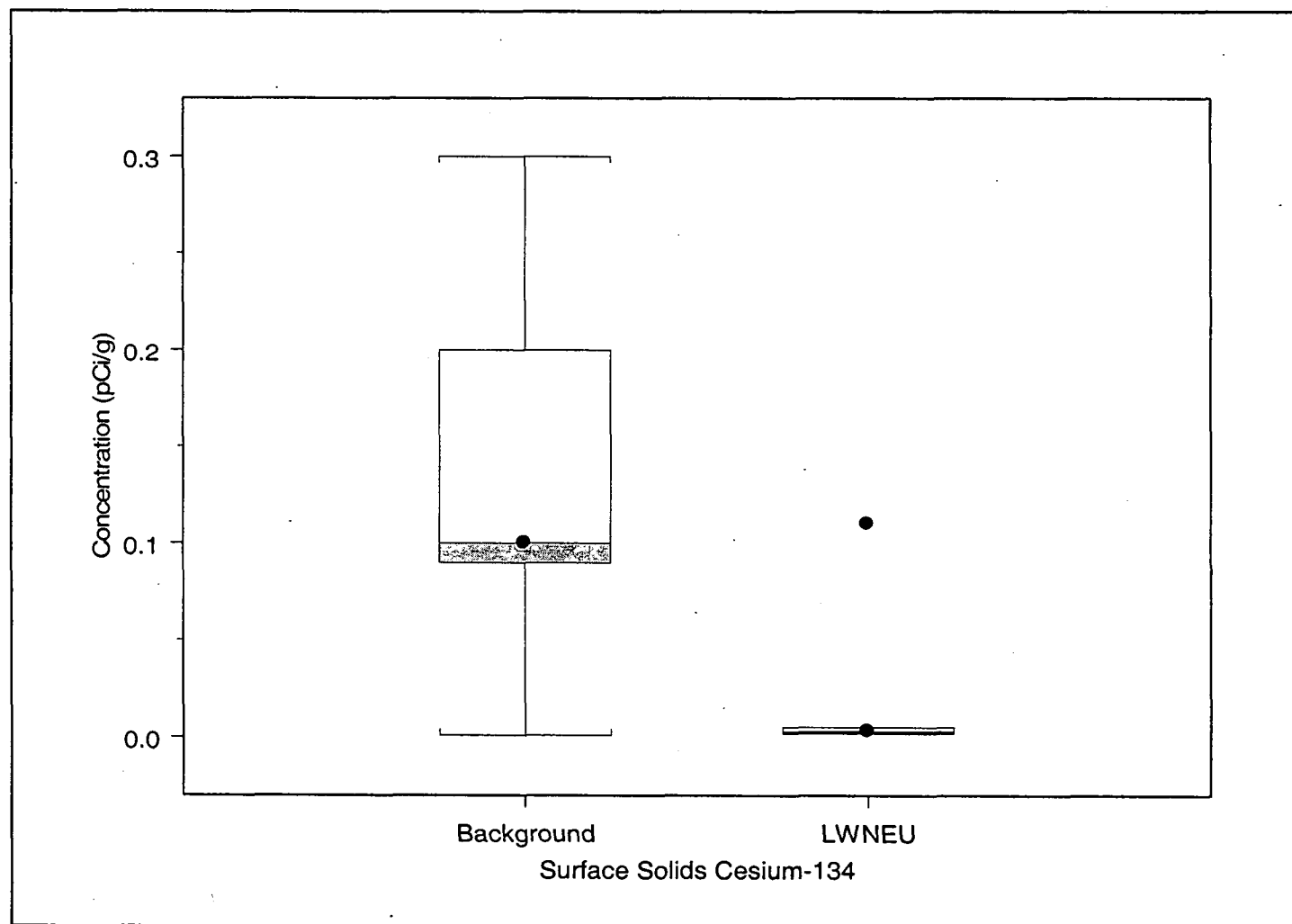
Figure A3.2.7  
LWNEU Surface Soil Box Plots for Cadmium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

173

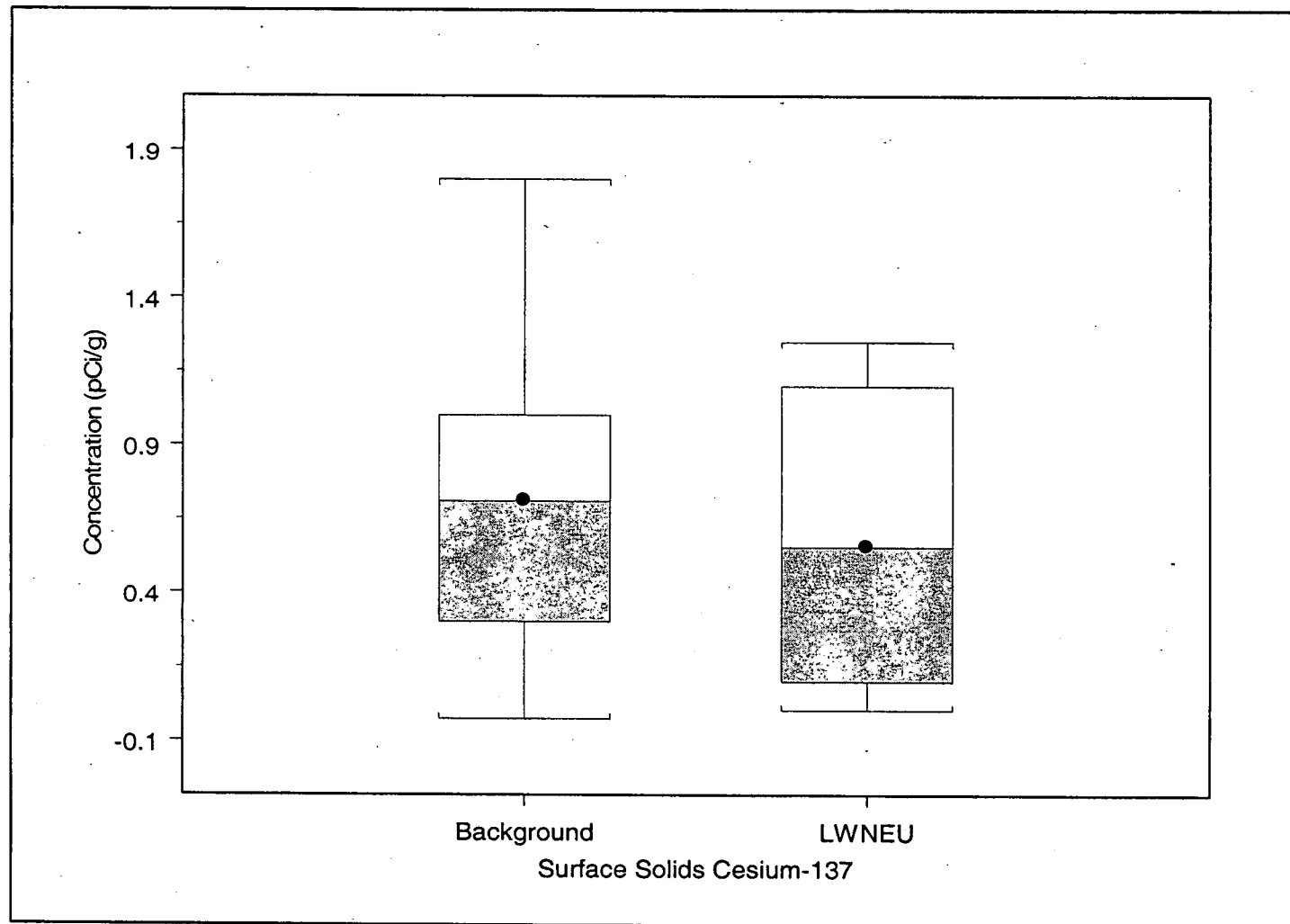
Figure A3.2.8  
LWNEU Surface Soil/Surface Sediment Box Plots for Cesium-134



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

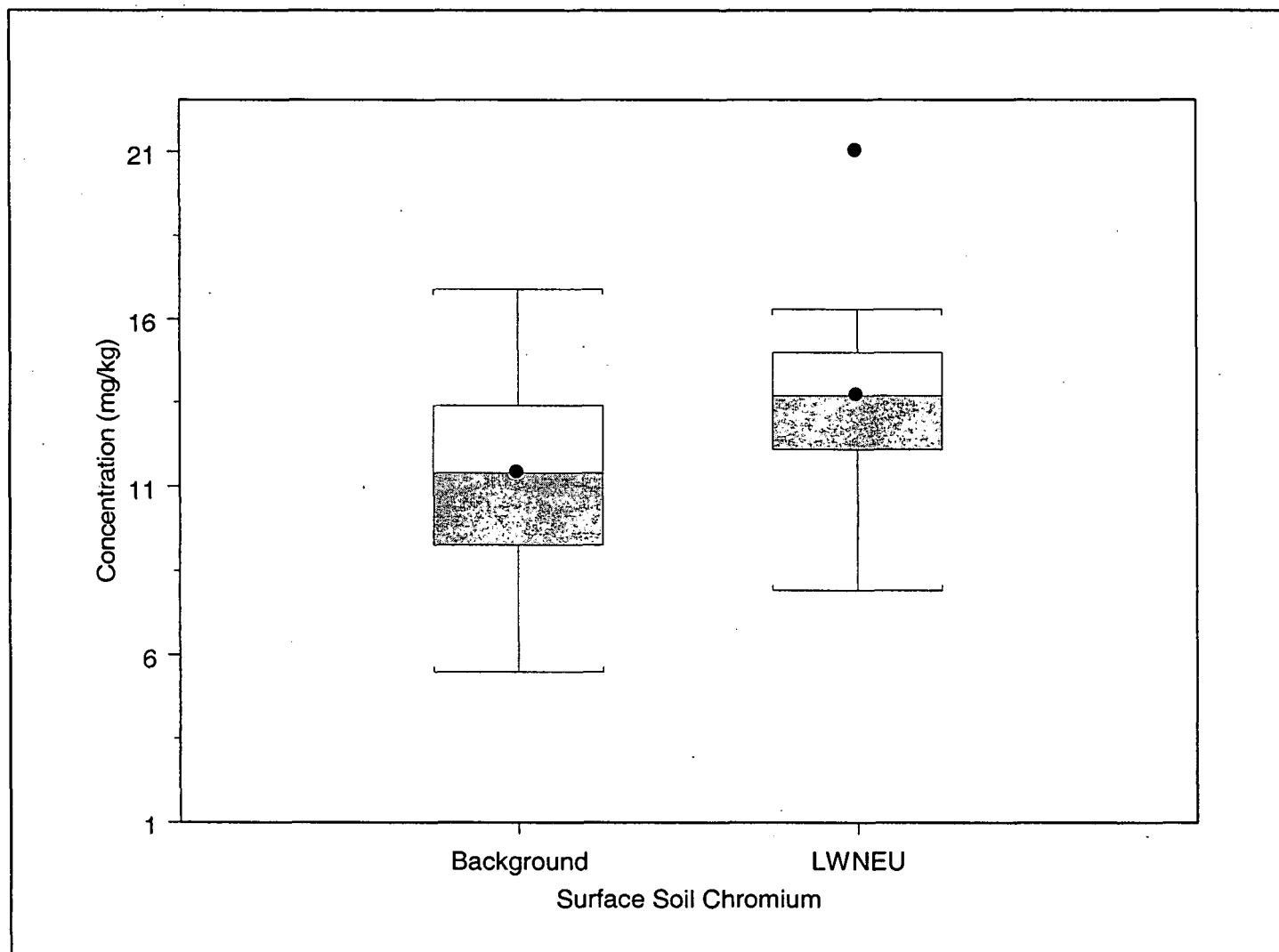
174

Figure A3.2.9  
 LWNEU Surface Soil/Surface Sediment Box Plots for Cesium-137



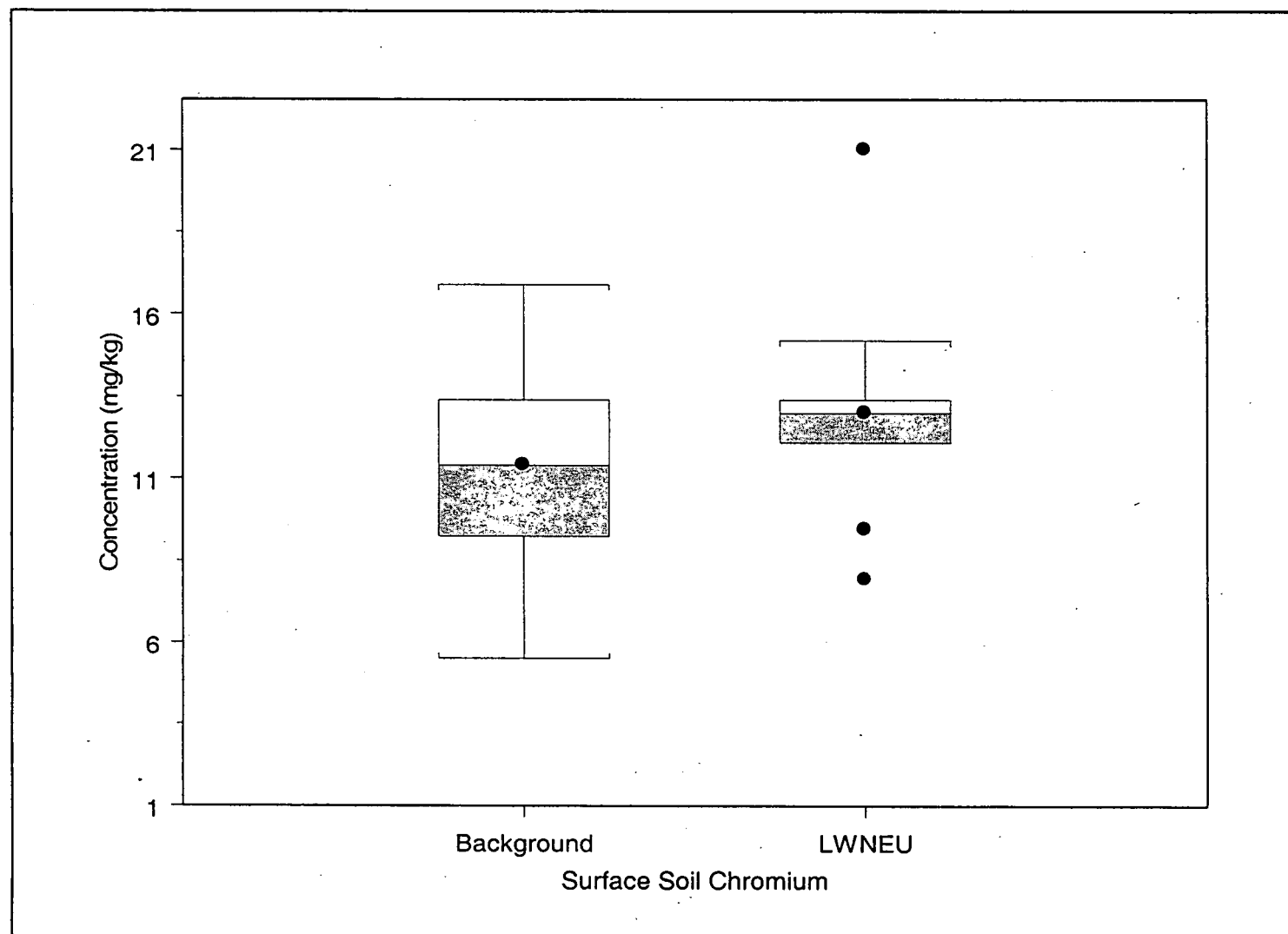
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 3.2.10  
LWNEU Surface Soil Box Plots for Chromium



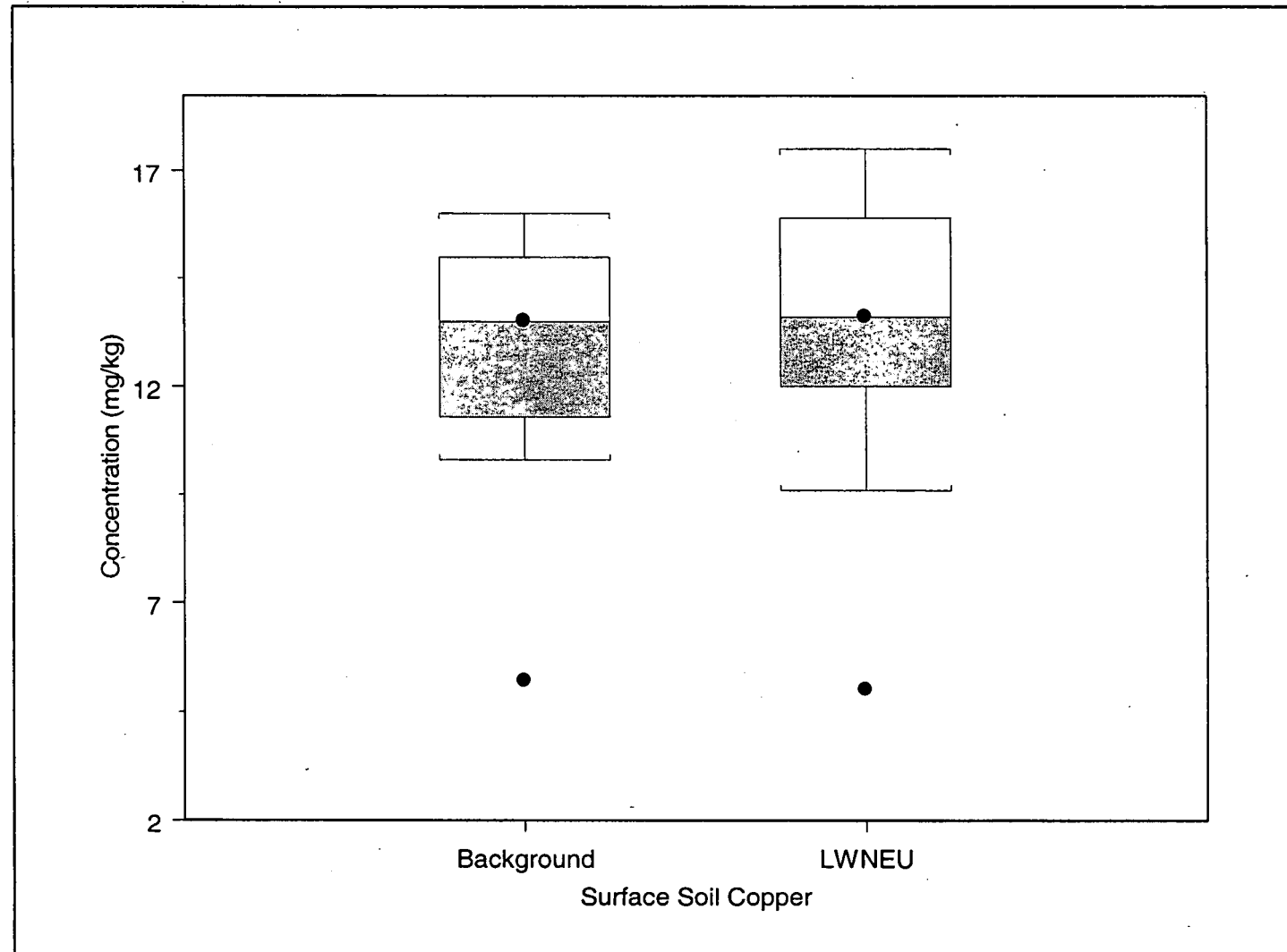
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 3.2.11  
LWNEU Surface Soil Box Plots for Chromium (PMJM)



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

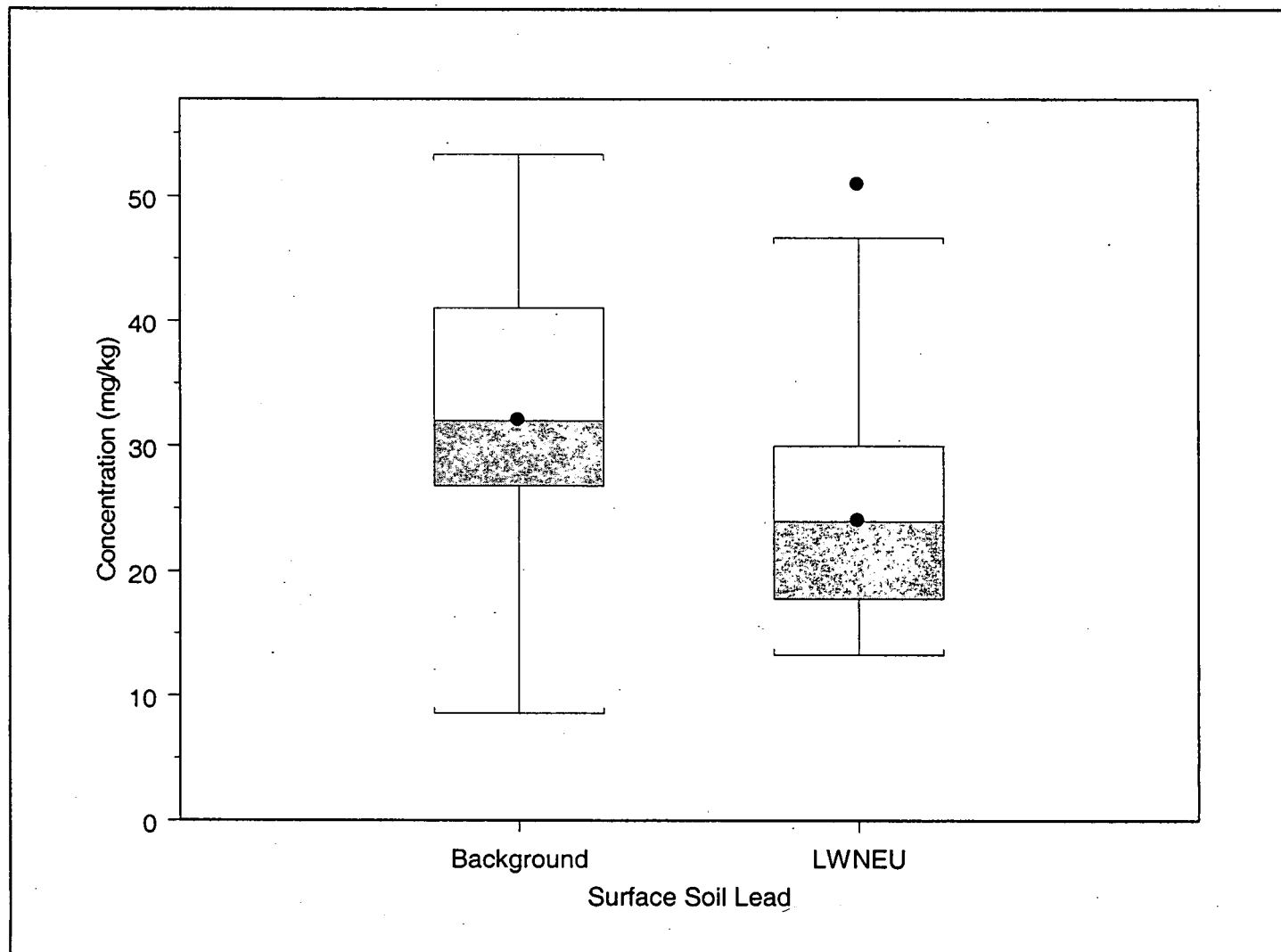
Figure A3.2.12  
LWNEU Surface Soil Box Plots for Copper



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

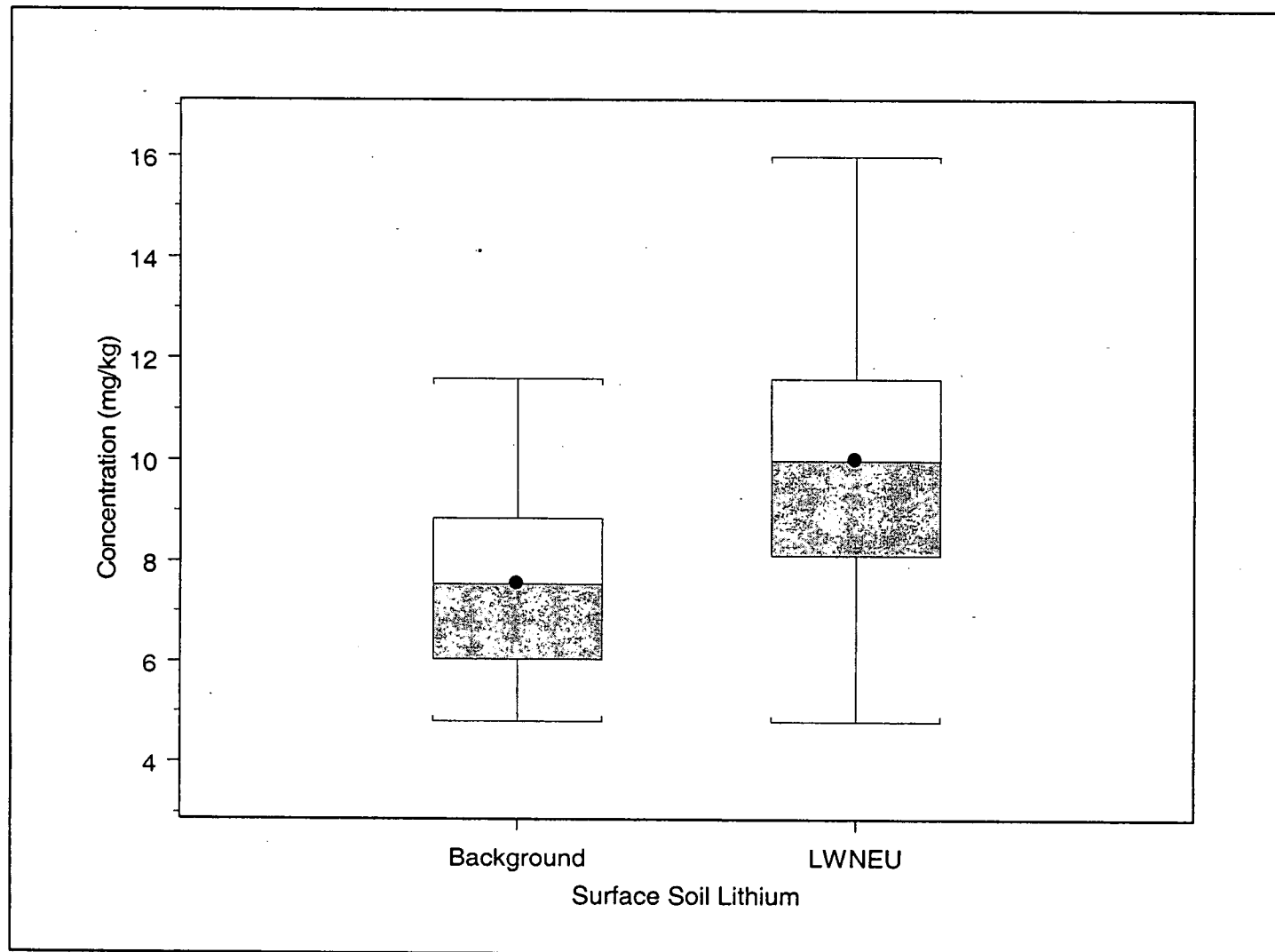
178

Figure 13.2.13  
LWNEU Surface Soil Box Plots for Lead



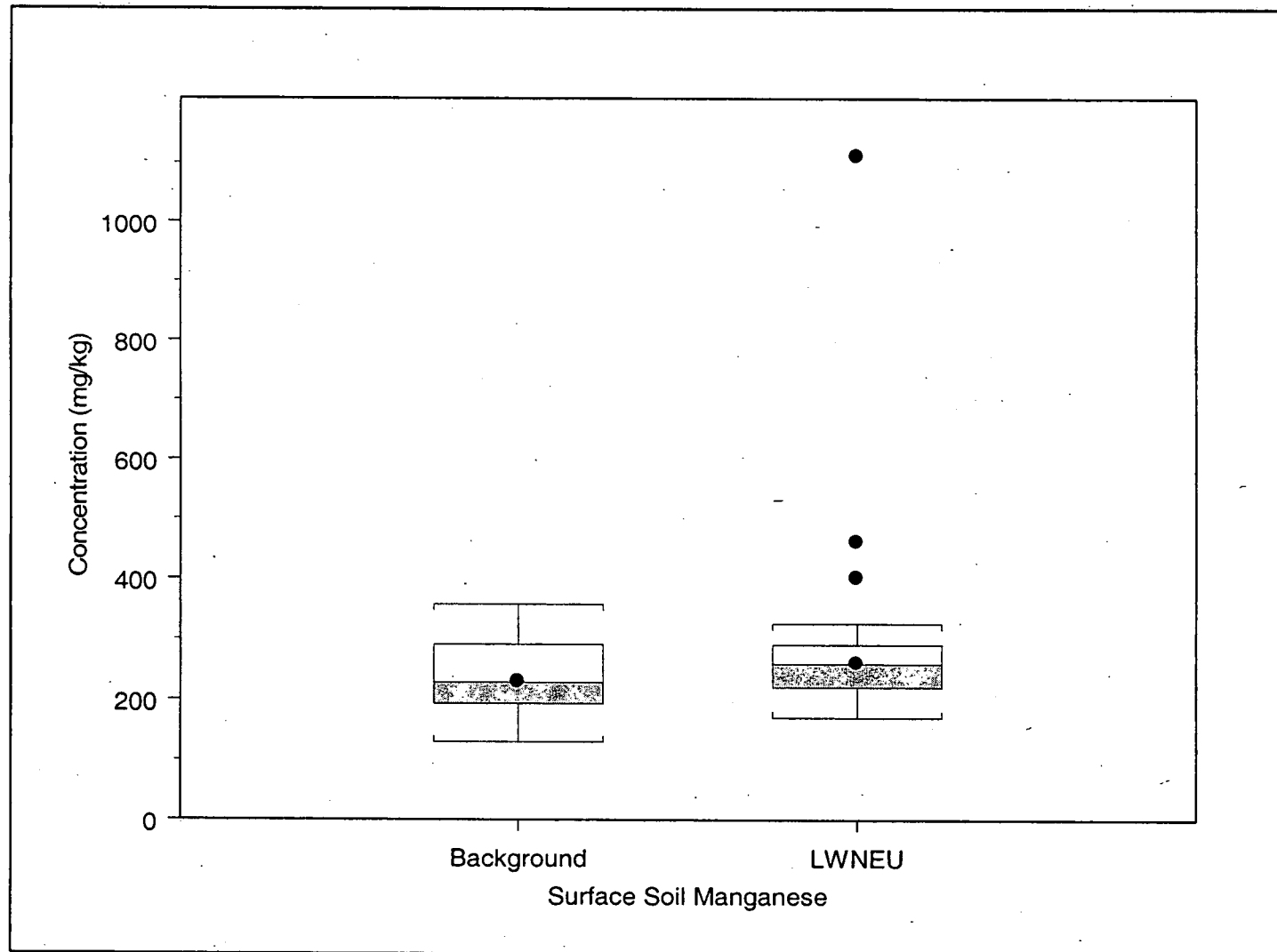
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.14  
LWNEU Surface Soil Box Plots for Lithium



18

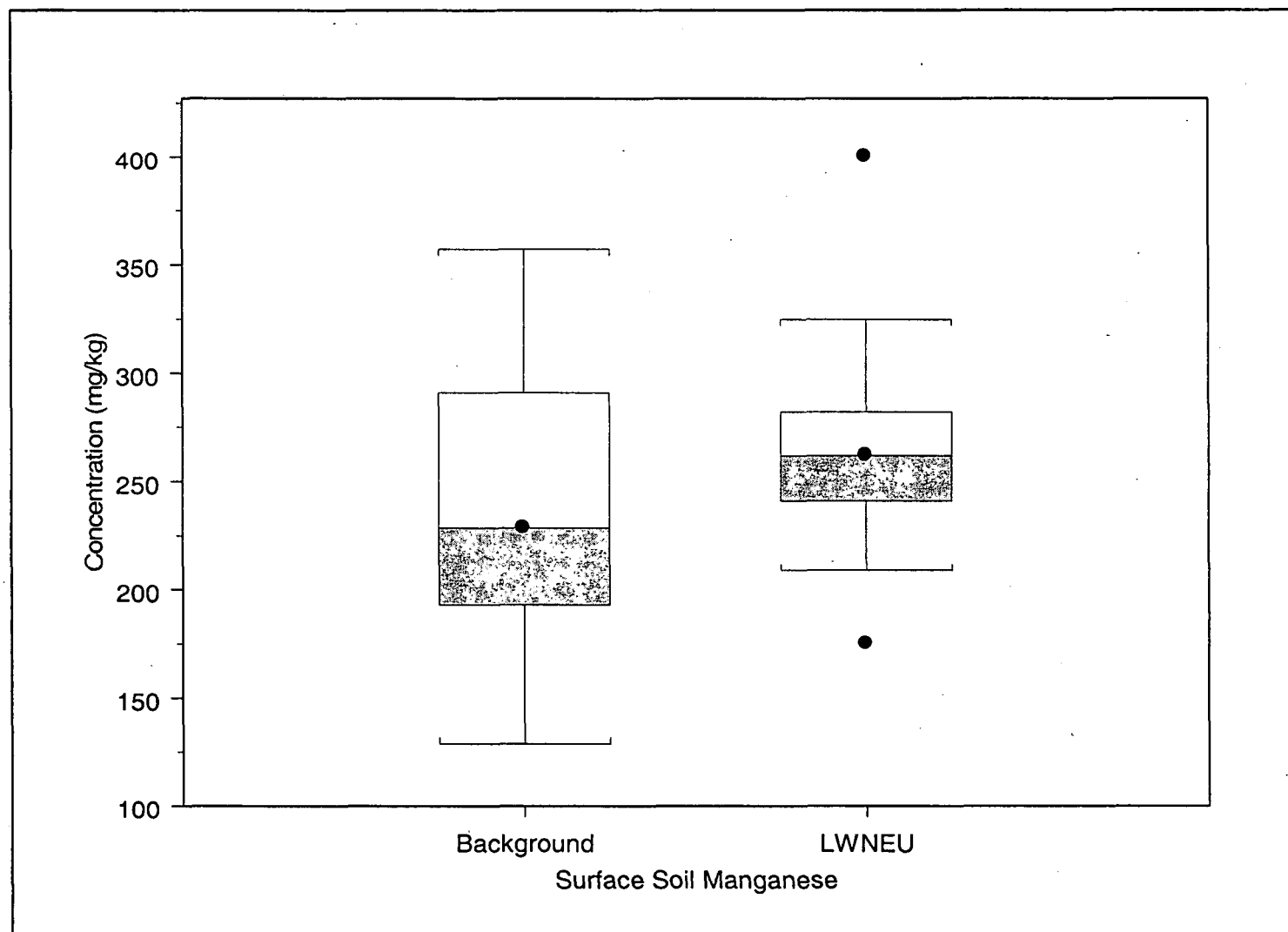
Figure 13.2.15  
LWNEU Surface Soil Box Plots for Manganese



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

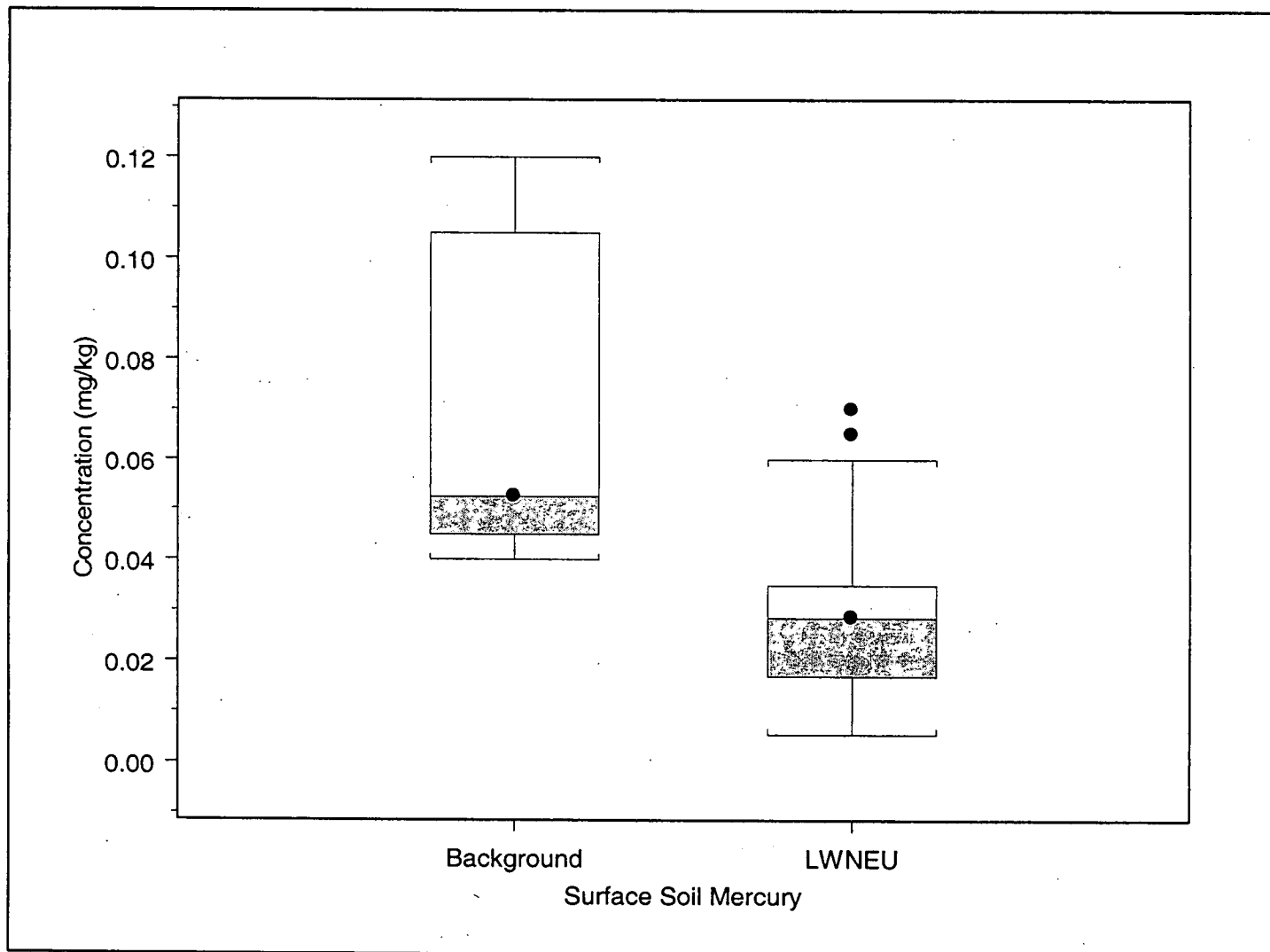
181

Figure 3.2.16  
LWNEU Surface Soil Box Plots for Manganese (PMJM)



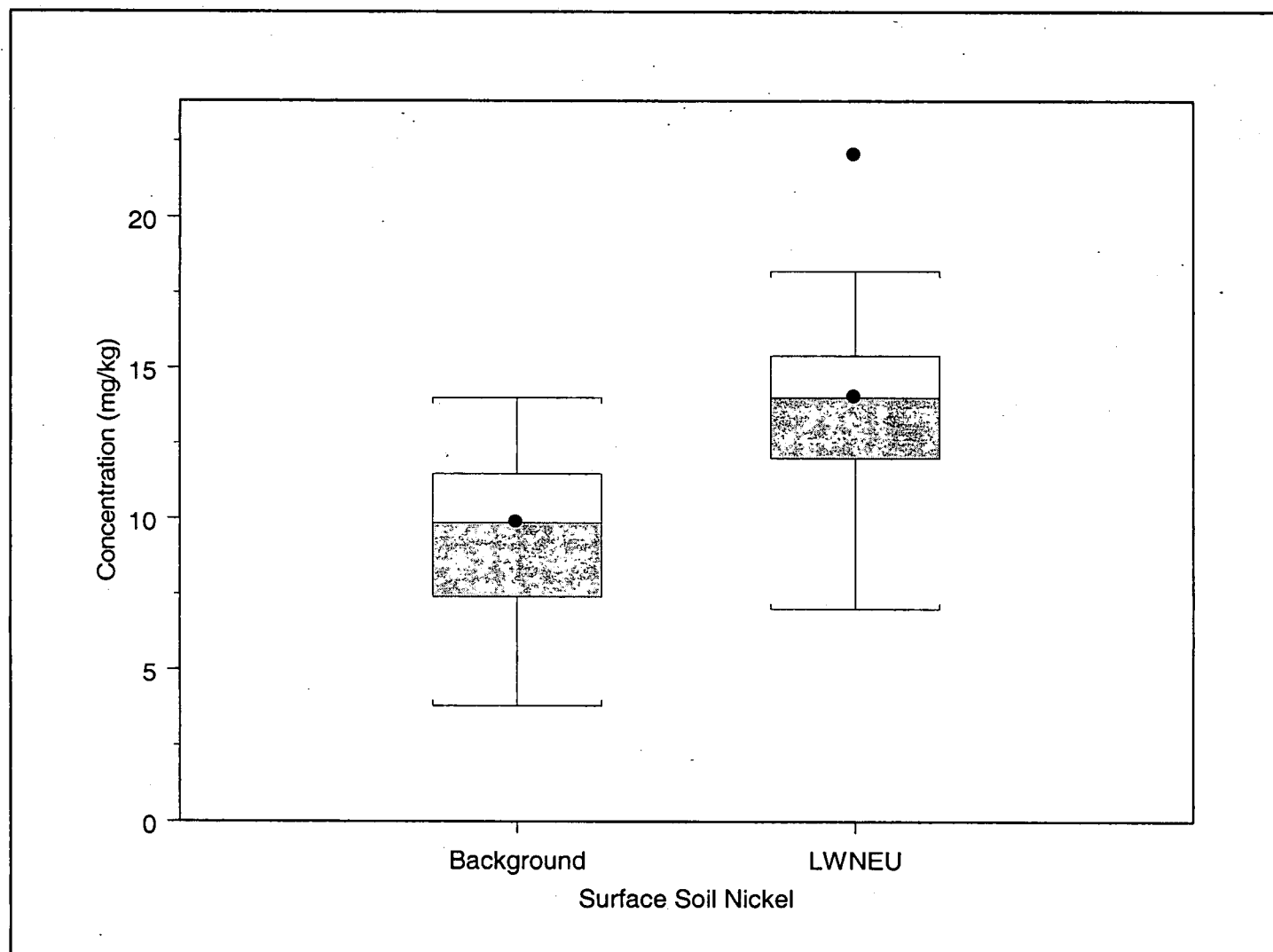
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.17  
LWNEU Surface Soil Box Plots for Mercury



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

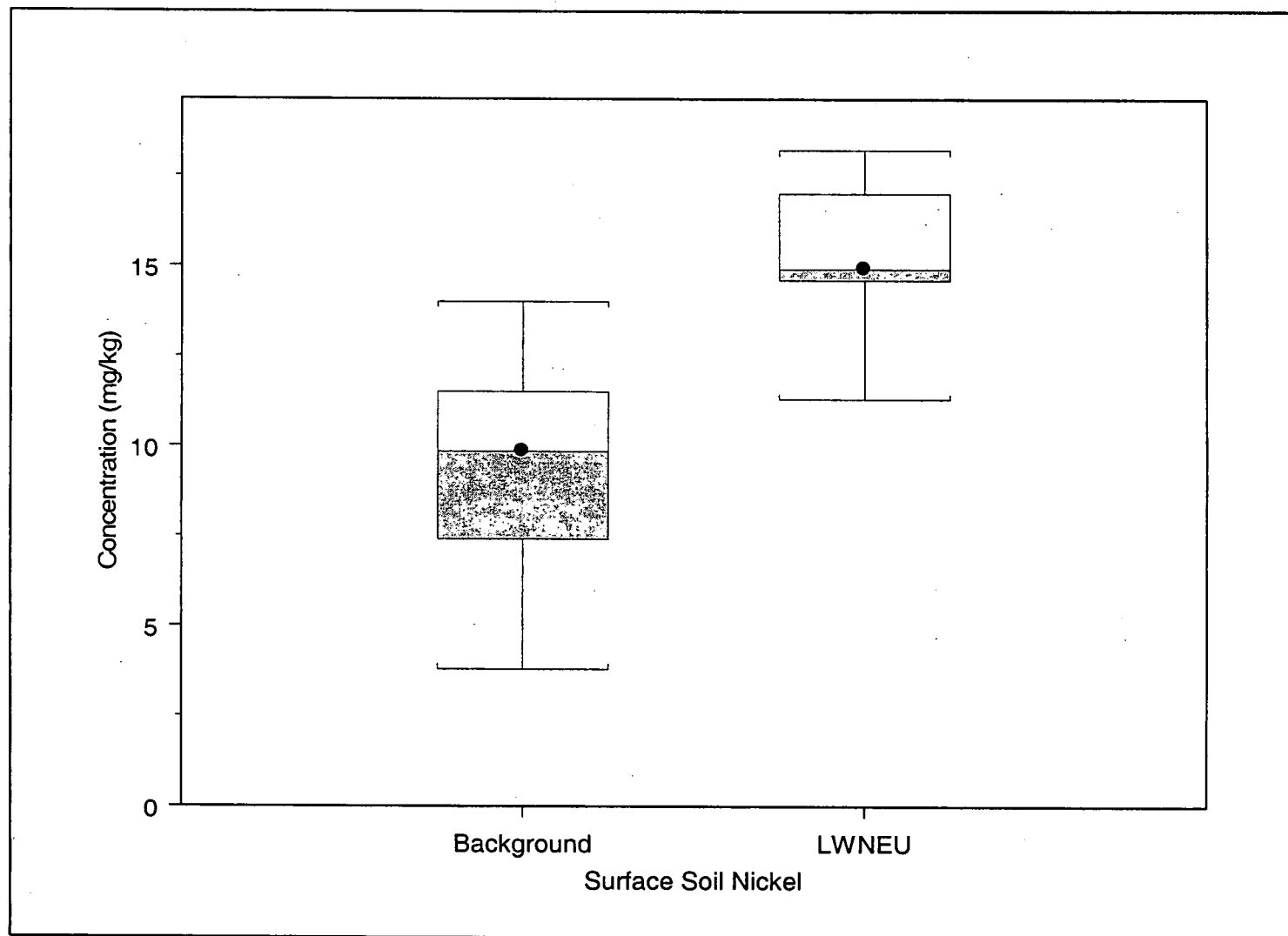
Figure A3.18  
LWNEU Surface Soil Box Plots for Nickel



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

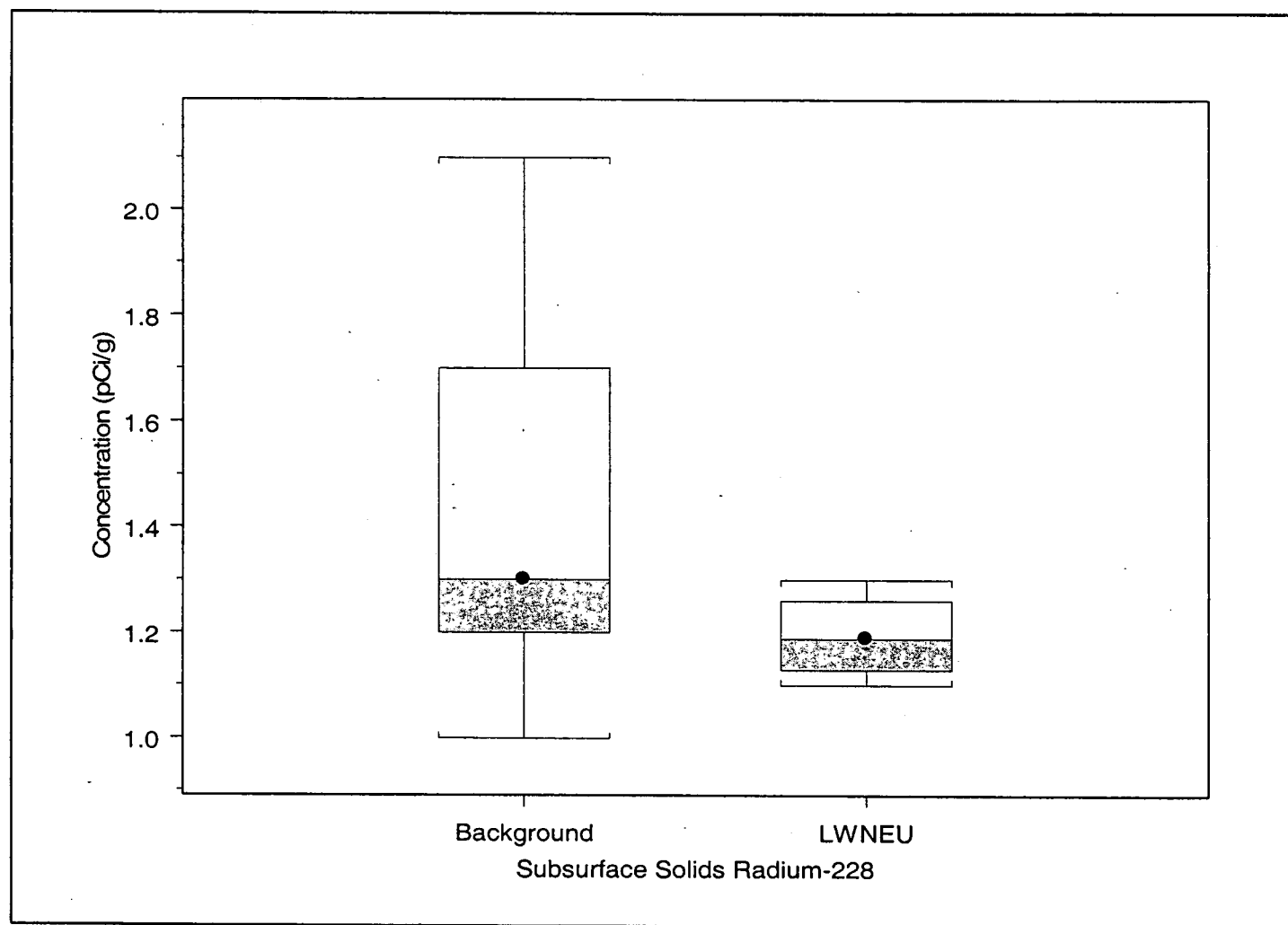
1/8

Figure 13.2.19  
LWNEU Surface Soil Box Plots for Nickel (PMJM)



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

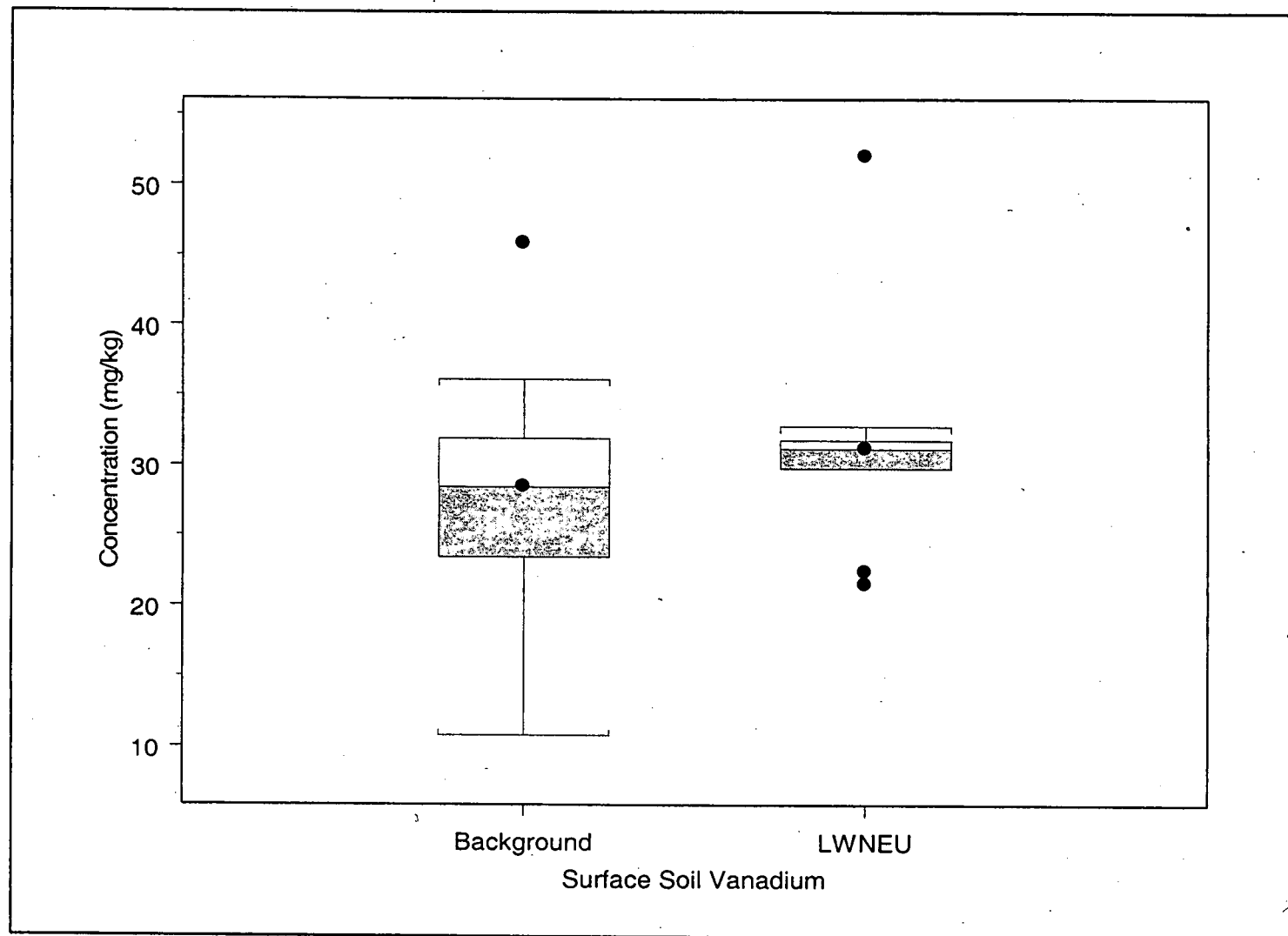
## LWNEU Subsurface Soil/Subsurface Sediment Box Plots for Radium-228



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

18

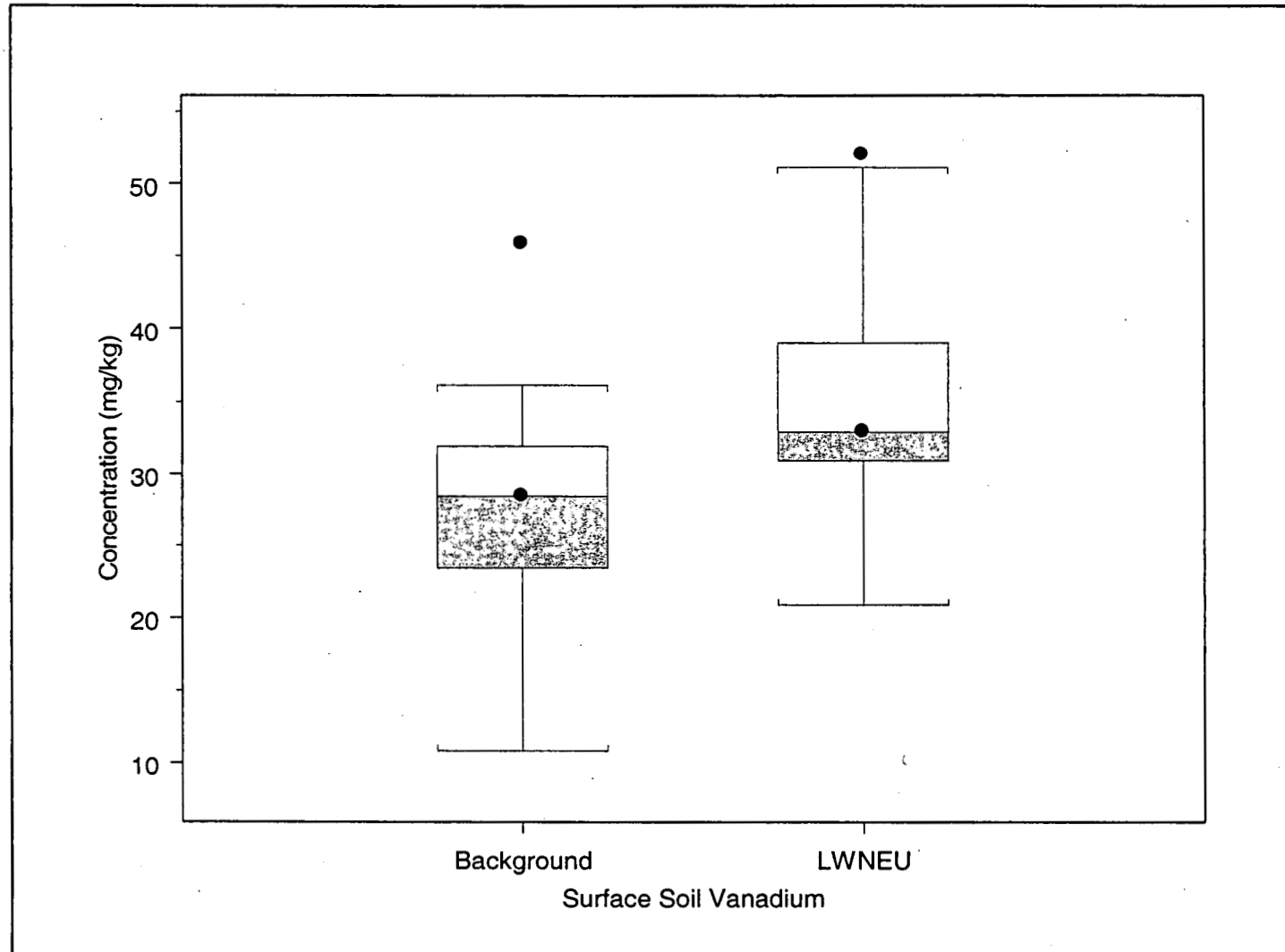
Figure 3.2.21  
LWNEU Surface Soil Box Plots for Vanadium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

187

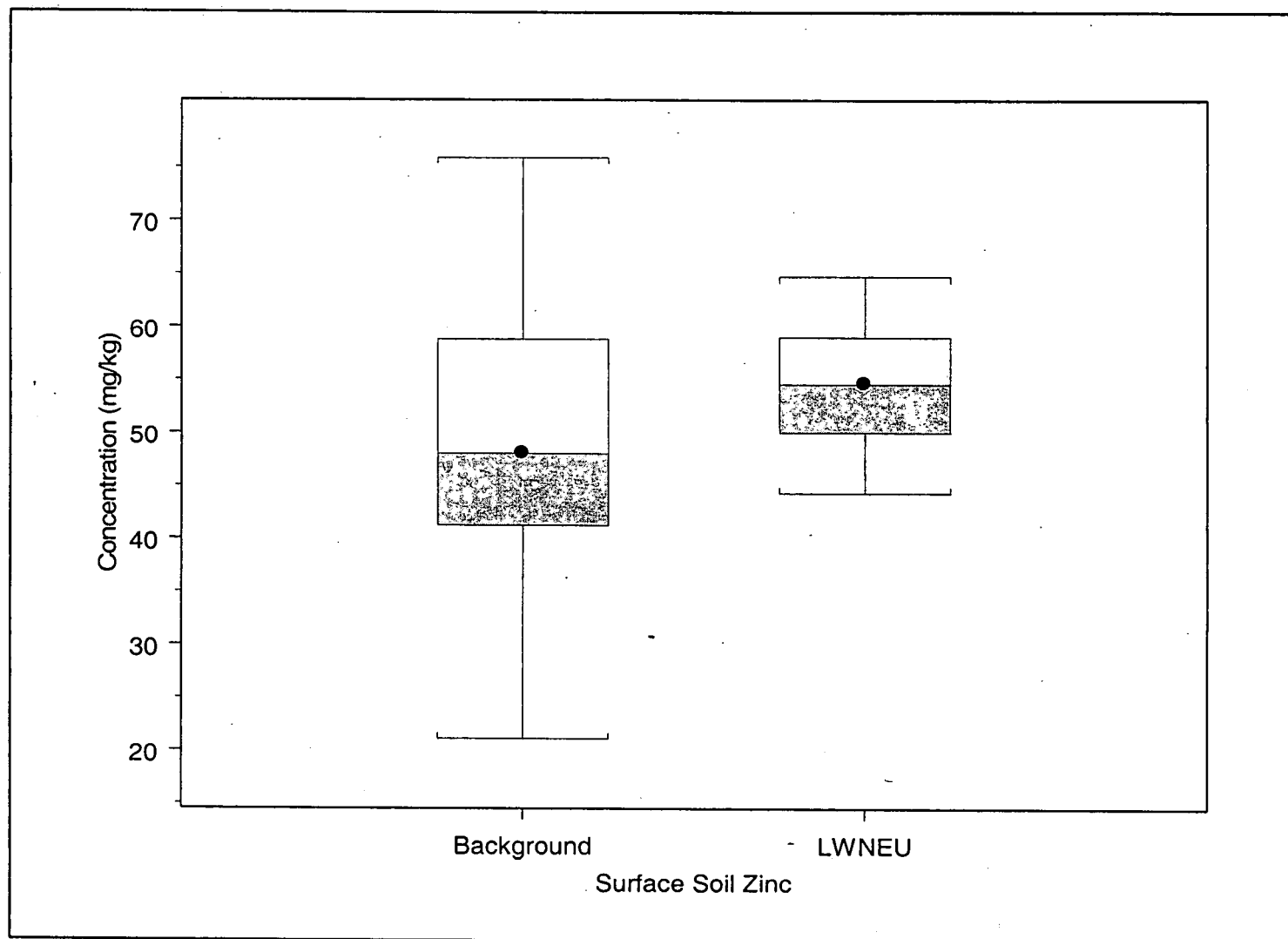
Figure A3.2.22  
LWNEU Surface Soil Box Plots for Vanadium (PMJM)



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

1/88

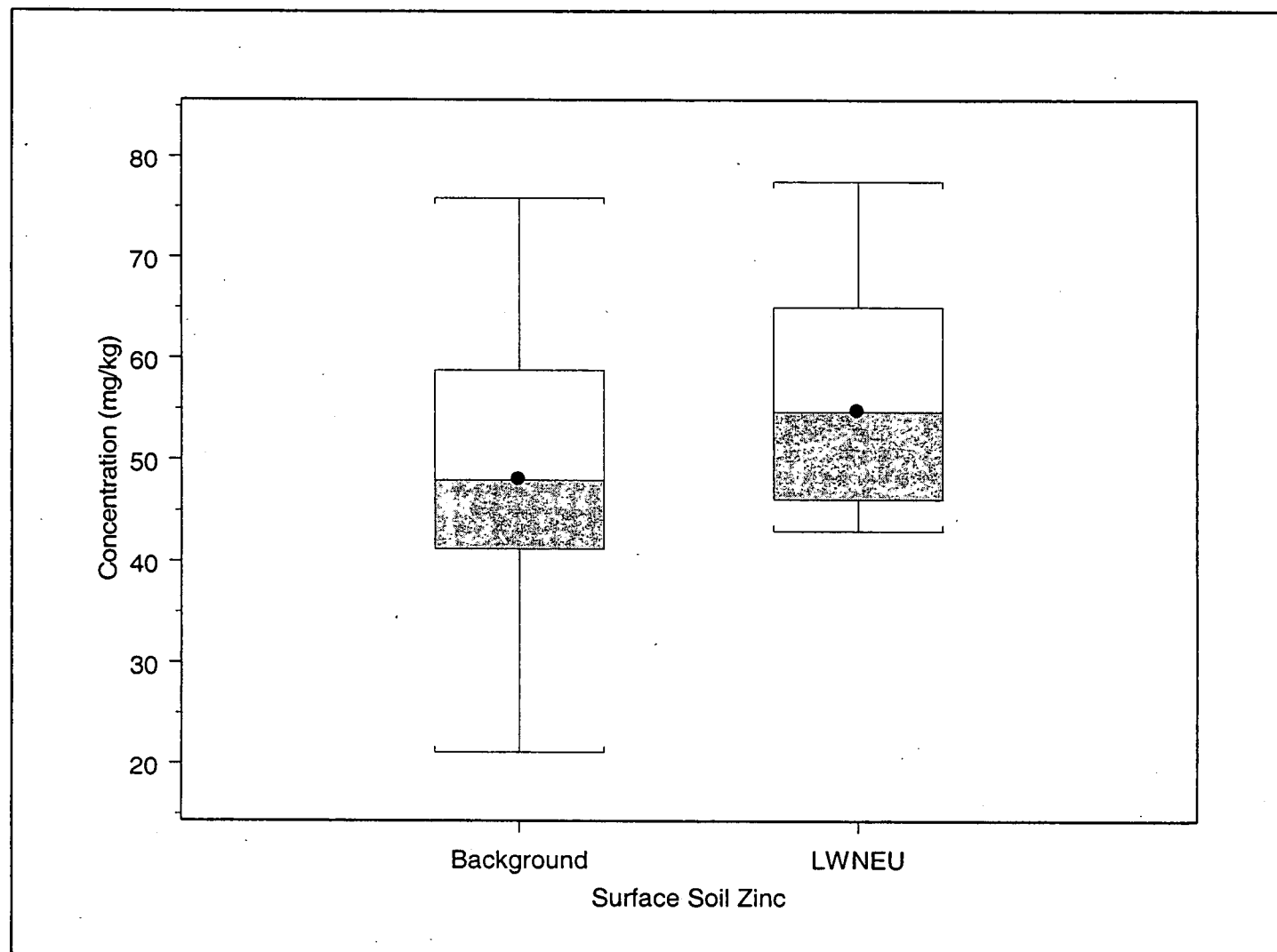
Figure 13.2.23  
LWNEU Surface Soil Box Plots for Zinc



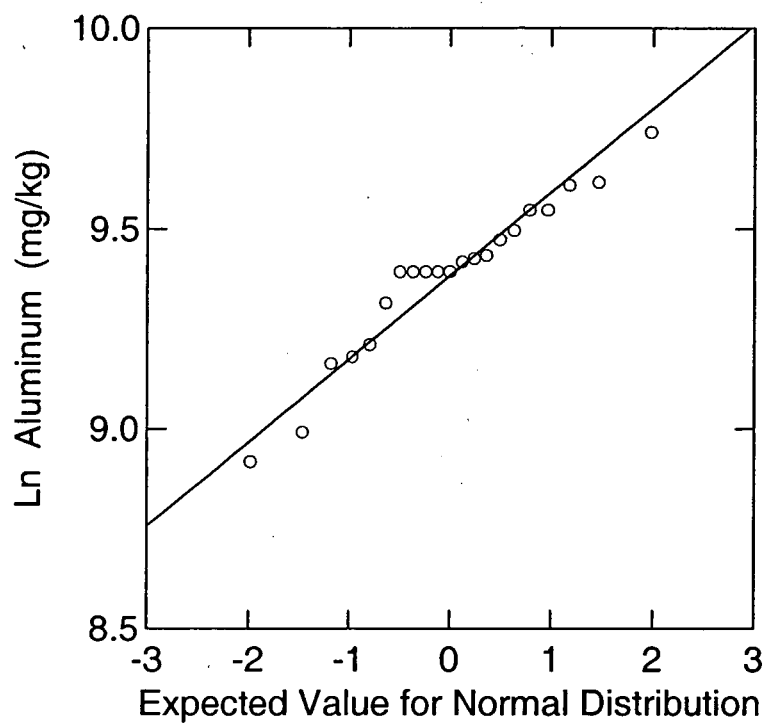
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

189

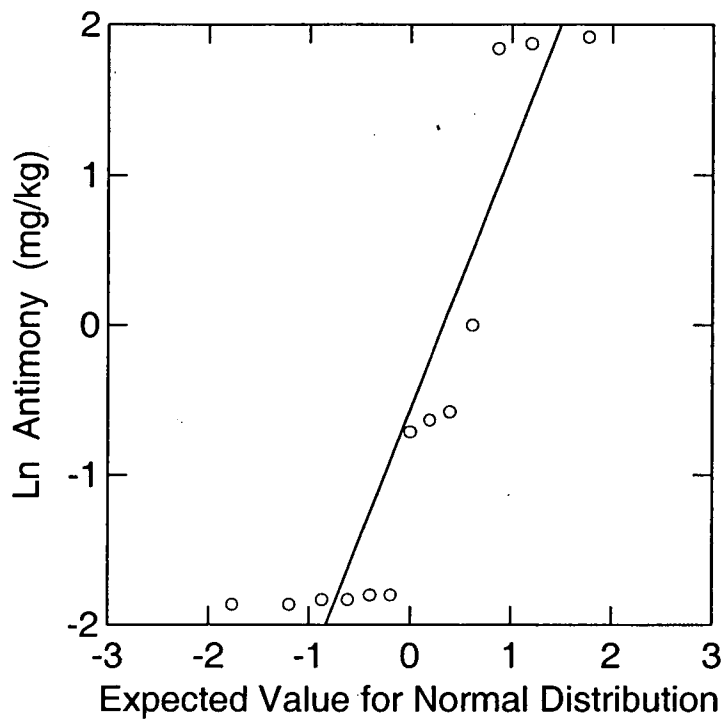
Figure A3.2.24  
LWNEU Surface Soil Box Plots for Zinc (PMJM)



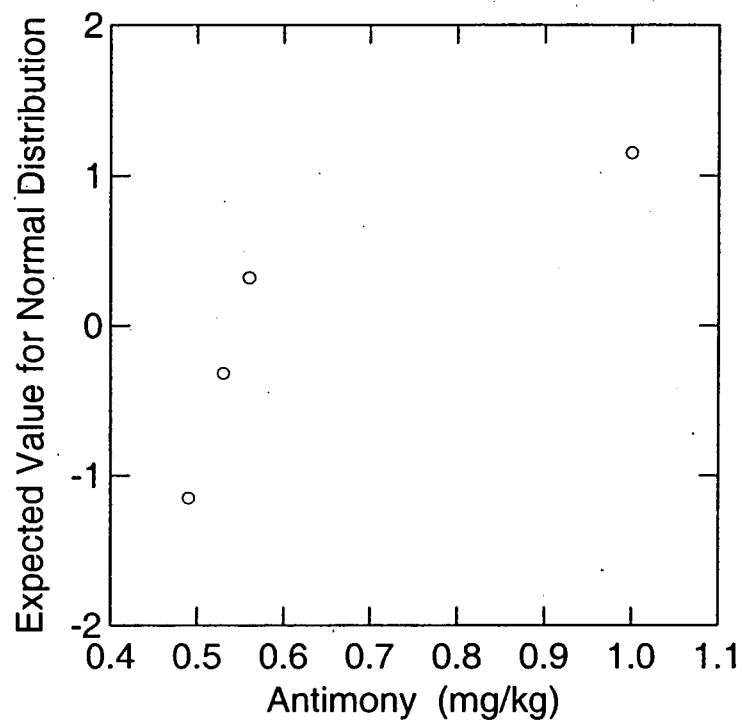
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.



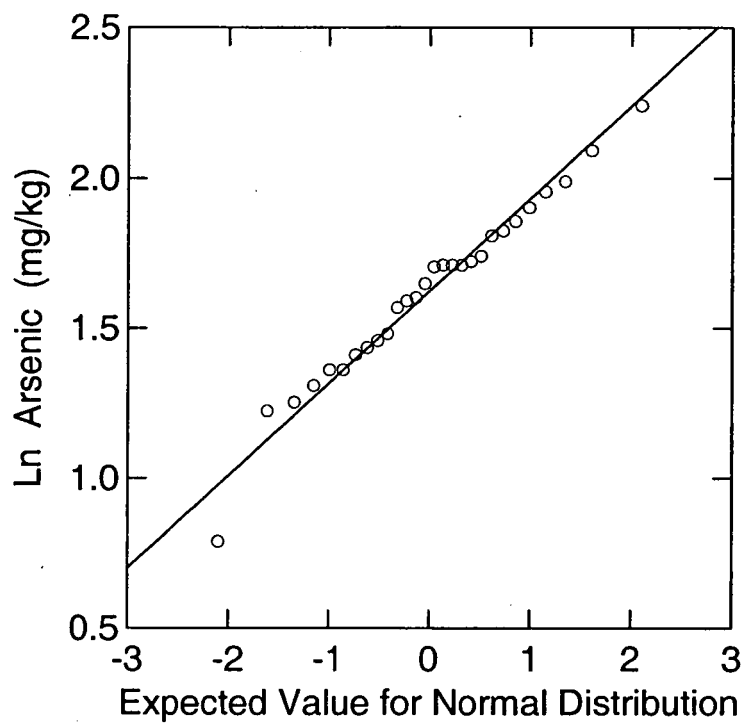
**Figure A3.4.1. Probability Plot for Aluminum Concentrations (Natural Logarithm) in LWNEU Surface Soil**



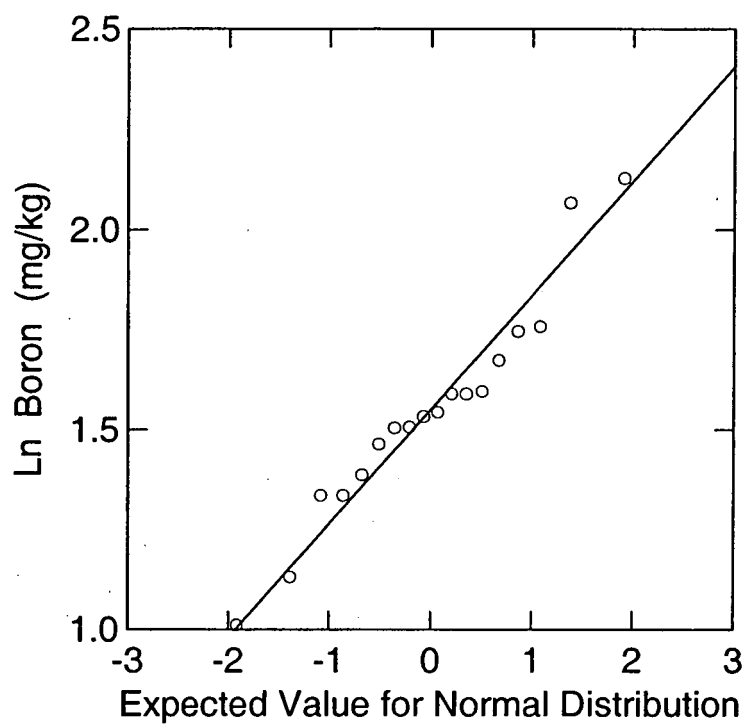
**Figure A3.4.2a. Probability Plot for Antimony Concentrations (Natural Logarithm) in LWNEU Surface Soil (Includes both detected and nondetected antimony concentrations)**



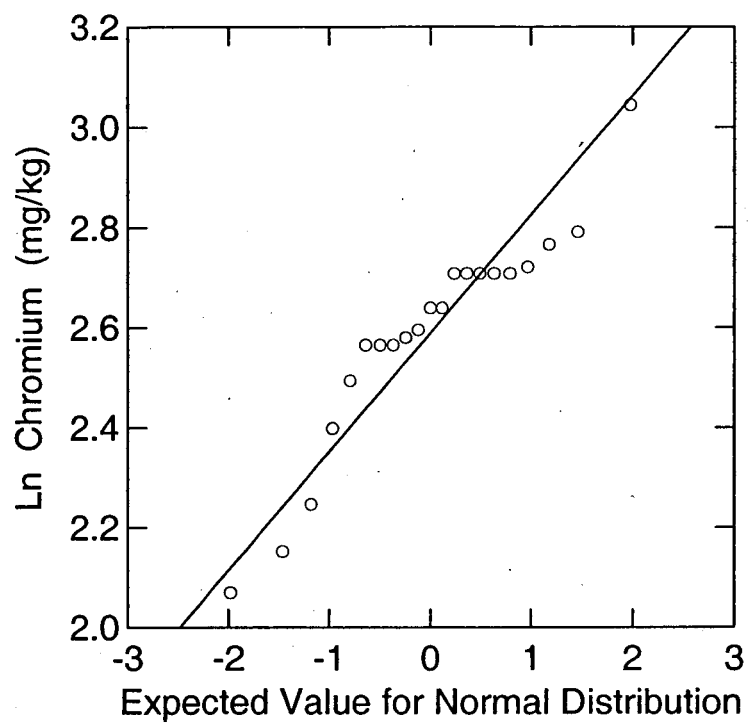
**Figure A3.4.2b. Probability Plot of Detected Antimony Concentrations (Natural Logarithm) in LWNEU Surface Soil (Nondetects have been removed)**



**Figure A3.4.3. Probability Plot for Arsenic Concentrations (Natural Logarithm) in LWNEU Surface Soil/Surface Sediment**



**Figure A3.4.4. Probability Plot for Boron Concentrations (Natural Logarithm) in LWNEU Surface Soil**



**Figure A3.4.5. Probability Plot for Chromium Concentrations (Natural Logarithm) in LWNEU Surface Soil**

Figure A3.4.6

4,4'-DDT  
Concentrations in Sitewide  
Surface Soil (Non-PMJM)

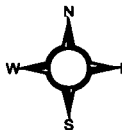
KEY

- Concentration > 3x ESL
- Concentration > ESL and ≤ 3x ESL
- Concentration ≤ ESL
- Nondetect (ND)

Min. Non-PMJM ESL = 1.20 ug/kg  
3 x Min. Non-PMJM ESL = 3.61 ug/kg

Standard Map Features

- Lower Walnut Drainage EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Ephemeral stream
- Intermittent stream
- Perennial stream
- Site boundary



0 1000 2000 Feet

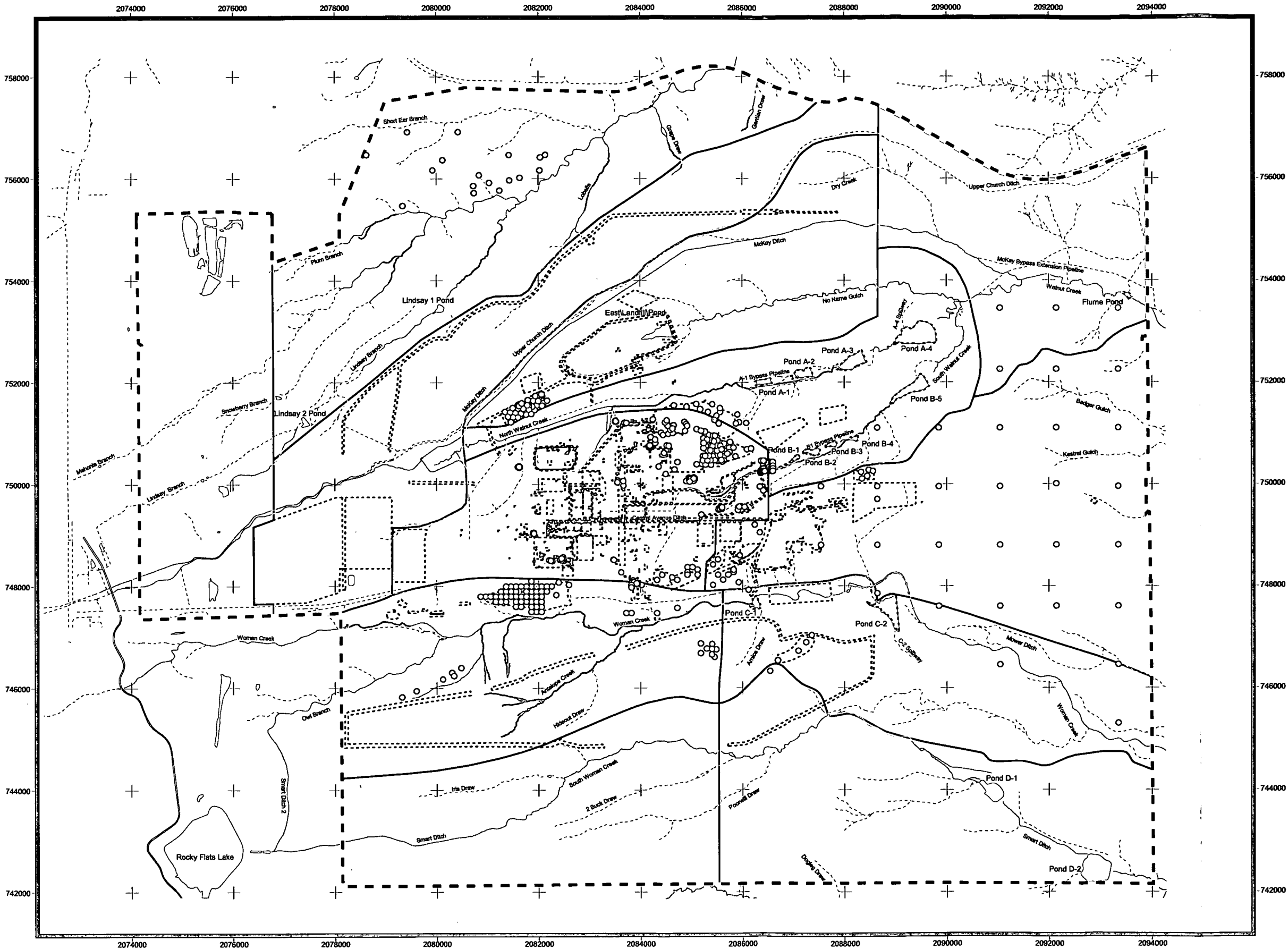
Scale 1:24,000

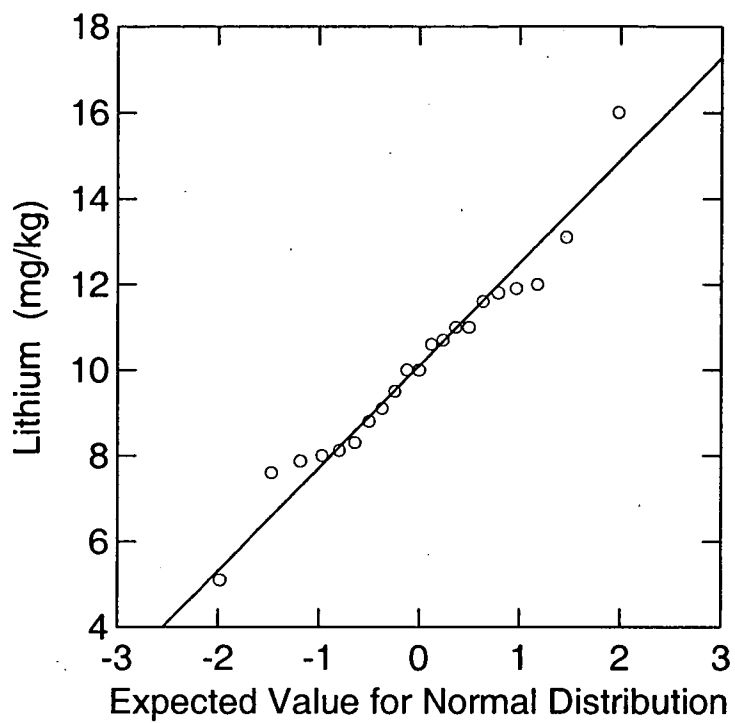
State Plane Coordinate Projection  
Colorado Central Zone  
Datum: NAD 27

U.S. Department of Energy  
Rocky Flats Environmental  
Technology Site

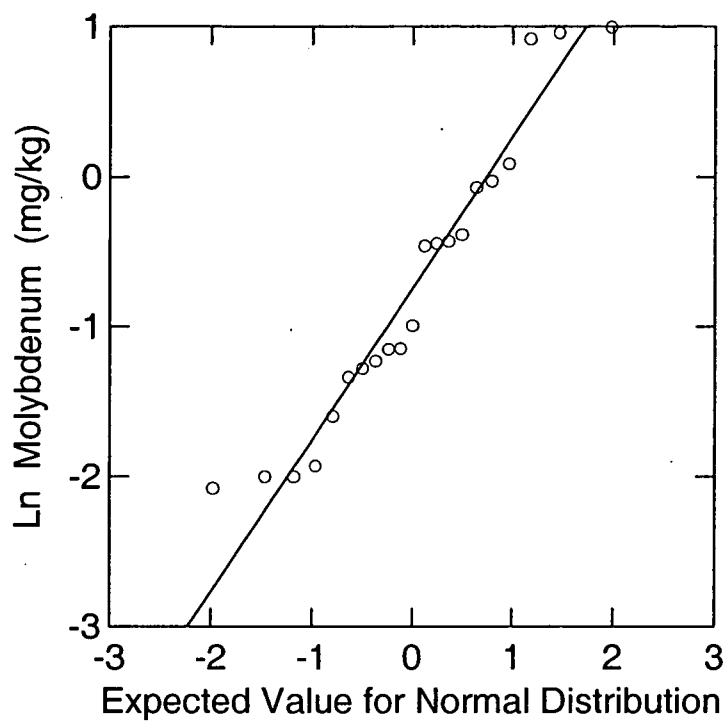


File: W:\Projects\FY2005\CRA\ProfessionalJudgment\FINAL-profjudgment.apr

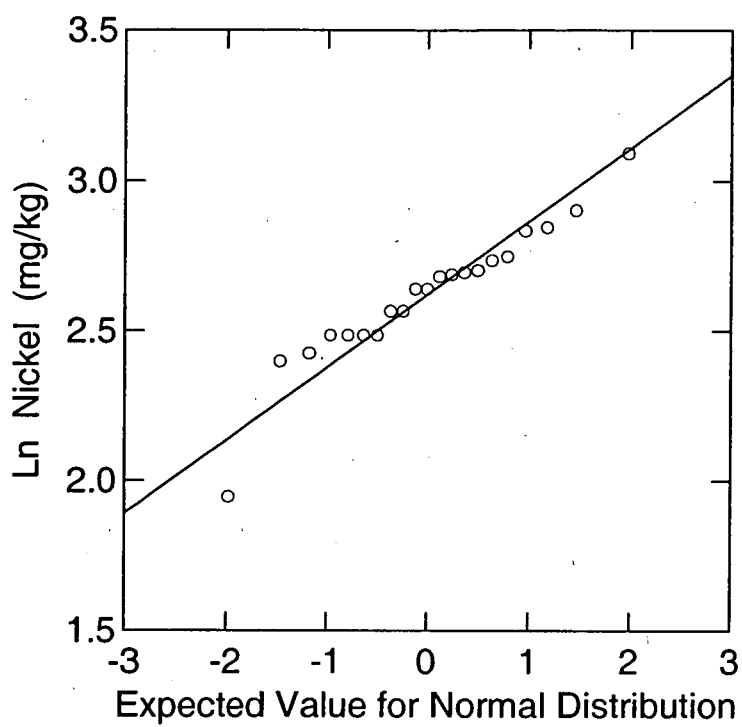




**Figure A3.4.7. Probability Plot for Lithium Concentrations (Natural Logarithm) in LWNEU Surface Soil**



**Figure A3.4.8. Probability Plot for Molybdenum Concentrations (Natural Logarithm) in LWNEU Surface Soil**



**Figure A3.4.9. Probability Plot for Nickel Concentrations (Natural Logarithm) in LWNEU Surface Soil**

**Figure A3.4.10**  
**Radium-228**  
**Activity in Sitewide**  
**Surface Soil/Surface Sediment**

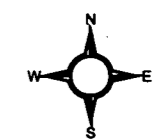
**KEY**

- Concentration > 3x Background MDC
- Concentration > Background MDC and ≤ 3x Background MDC
- Concentration > WRW PRG and ≤ Background MDC
- Concentration ≤ WRW PRG
- Nondetect (ND)

WRW PRG = 0.111 pCi/g  
 Background MDC = 4.10 pCi/g  
 3 x Background MDC = 12.3 pCi/g

**Standard Map Features**

- ▭ Lower Walnut Drainage EU
- ▭ Exposure Unit boundaries
- ▭ Former building where analyte was used or generated as waste
- ▭ Historical IHSS/PAC
- ▭ Pond
- Ephemeral stream
- Intermittent stream
- Perennial stream
- - - Site boundary



0 1000 2000 Feet

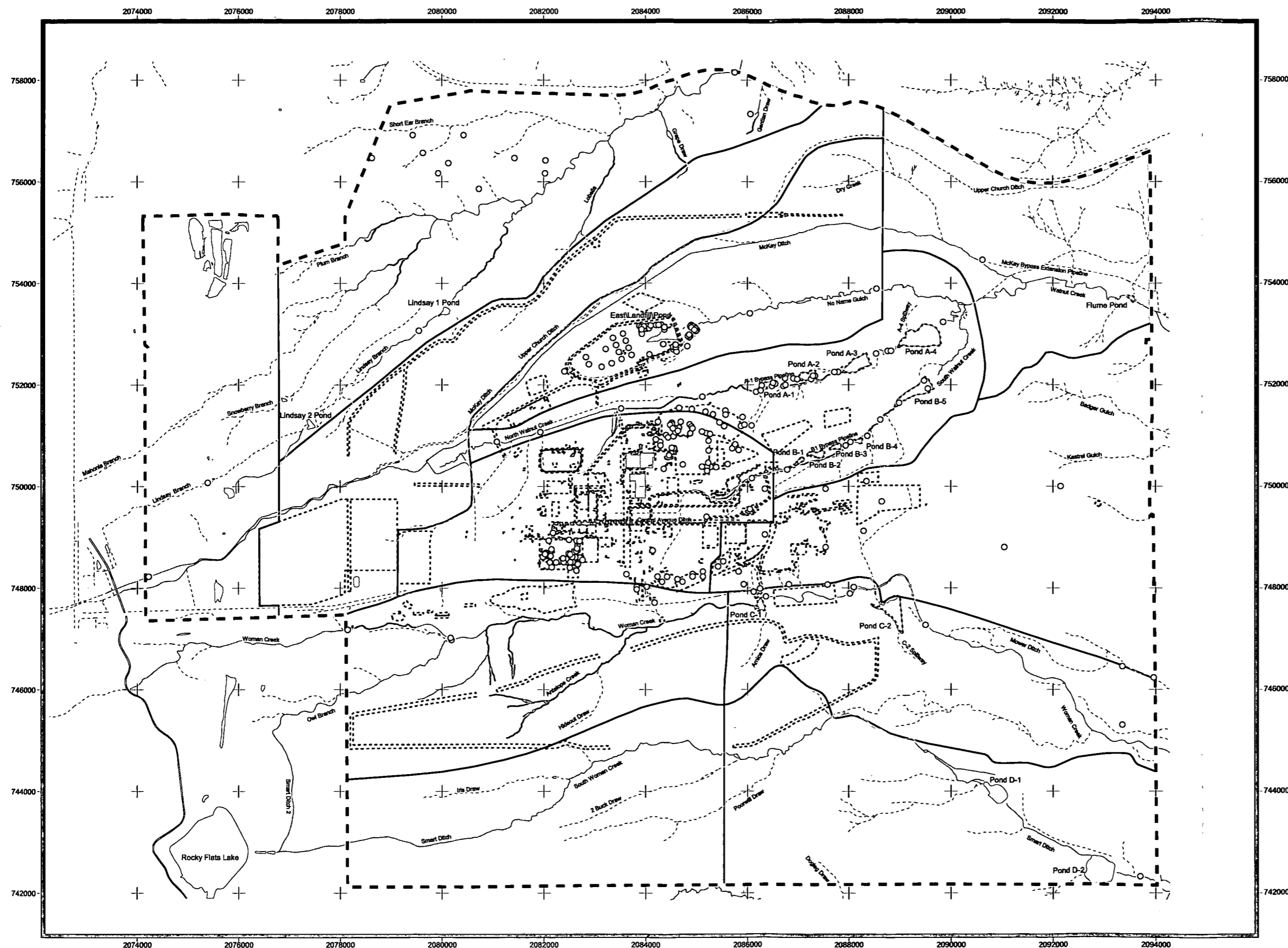
Scale 1:24,000

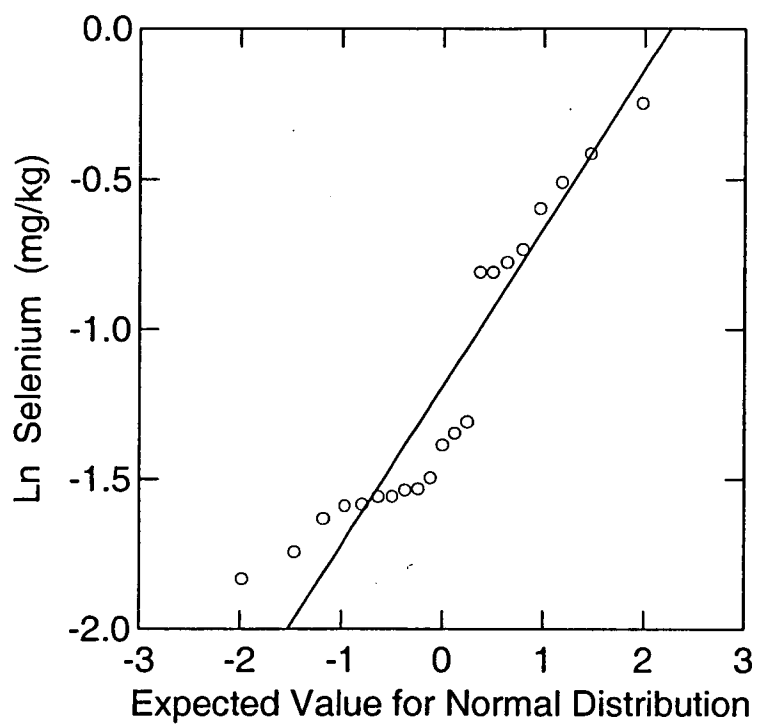
State Plane Coordinate Projection  
 Colorado Central Zone  
 Datum: NAD 27

U.S. Department of Energy  
 Rocky Flats Environmental  
 Technology Site

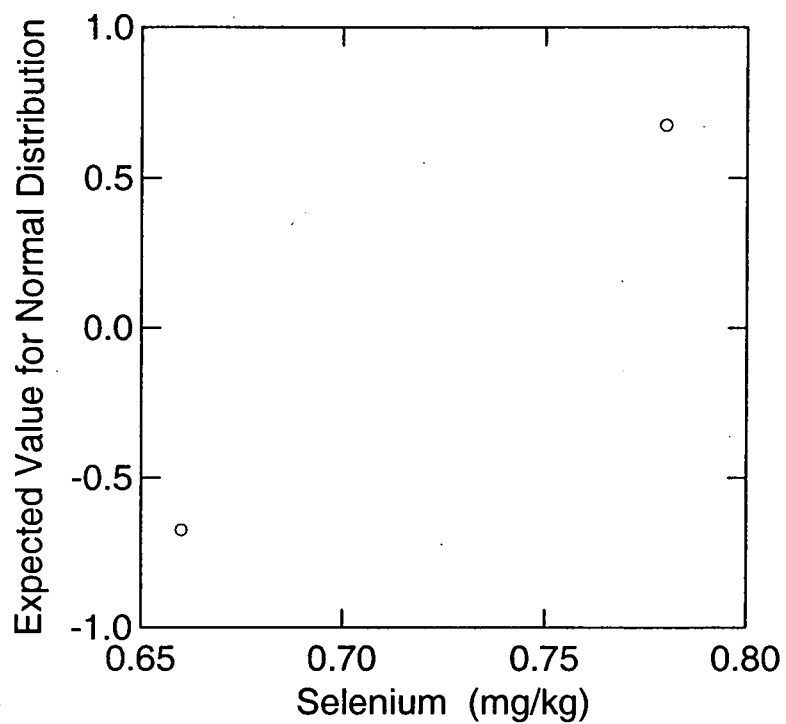


File: W:\Projects\FY2005\CRA\ProfessionalJudgment\FINAL-profjudgment.apr





**Figure A3.4.11a. Probability Plot for Selenium Concentrations (Natural Logarithm) in LWNEU Surface Soil (Includes both detected and nondetected concentrations).**



**Figure A3.4.11b. Probability Plot of Detected Selenium Concentrations (Natural Logarithm) in LWNEU Surface Soil**

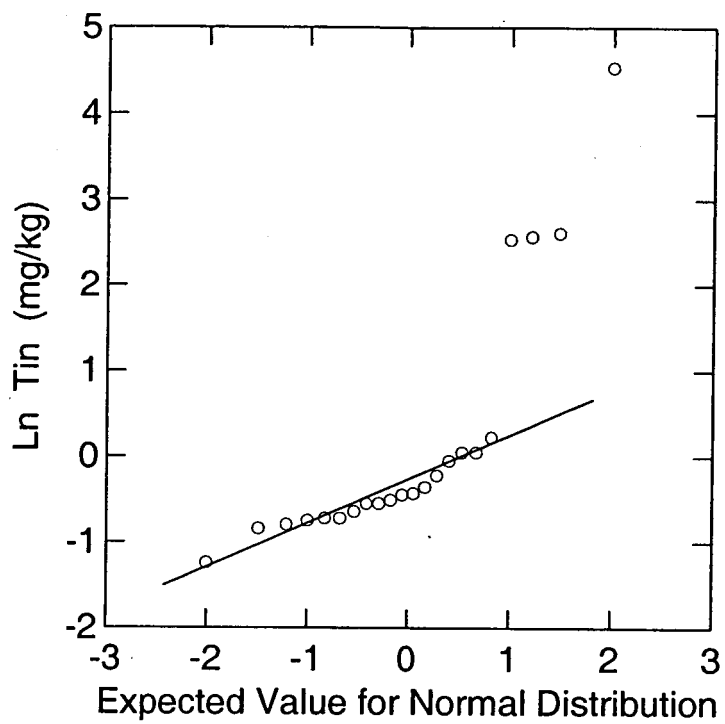
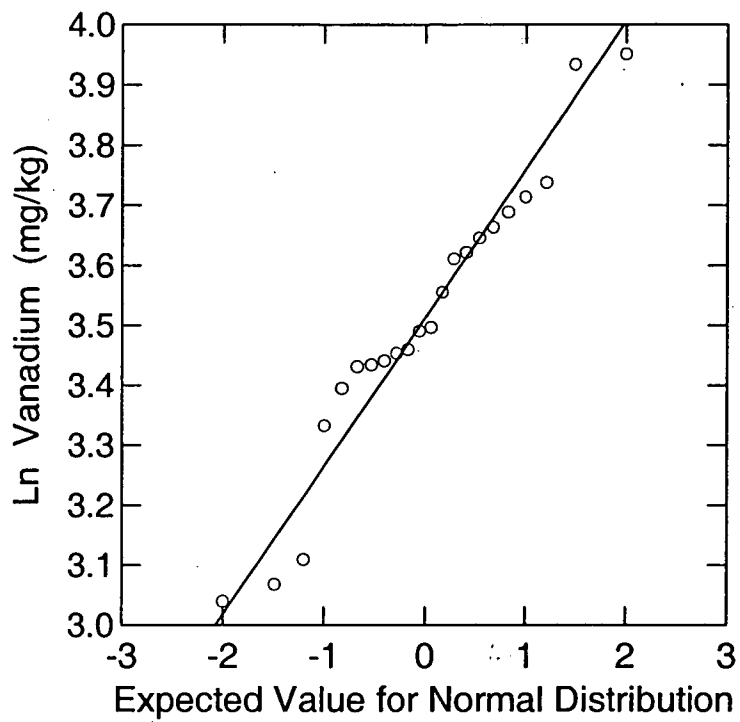
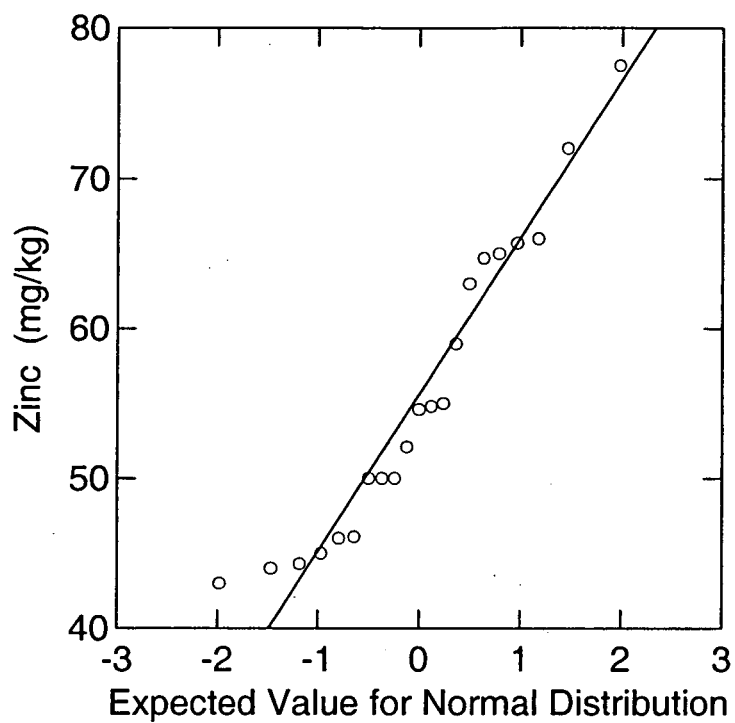


Figure A3.4.12. Probability Plot for Tin Concentrations (Natural Logarithm) in LWNEU Surface Soil



**Figure A3.4.13. Probability Plot for Vanadium Concentrations (Natural Logarithm) in LWNEU Surface Soil**



**Figure A3.4.14. Probability Plot for Zinc Concentrations (Natural Logarithm) in LWNEU Surface Soil**

**COMPREHENSIVE RISK ASSESSMENT**

**LOWER WALNUT DRAINAGE EXPOSURE UNIT**

**VOLUME 8: ATTACHMENT 4**

**Risk Assessment Calculations**

## TABLE OF CONTENTS

### 1.0 ECOLOGICAL RISK ASSESSMENT TABLES

Table A4.2.1 Non-PMJM Intake Estimates for 4,4'-DDT – Default Exposure Scenario

Table A4.2.2 Hazard Quotients for Surface Soils in the LWNEU – 4,4'-DDT

## **INTER-DRAINAGE EXPOSURE UNIT**

### **1.0 Ecological Risk Assessment Tables**

**Table A4.2.1**  
**Non-PMJM Intake Estimates for 4,4'-DDT - Default Exposure Scenario**  
**Bioaccumulation Factors**

Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.0800	32.4	28.5				
Media Concentrations (mg/kg)						
Soil Concentration	Statistic	Plant	Earthworm	Small Mammal	Surface Water (mg/L)	
0.0260	Tier 1 UTL	0.00208	0.842	0.740	0	
0.0235	Tier 1 UCL	0.00188	0.761	0.669	0	
0.0192	Tier 2 UTL	0.00154	0.622	0.546	0	
0.0149	Tier 2 UCL	0.00119	0.483	0.424	0	
Intake Parameters						
	IR <sub>food</sub> (kg/kg BW day)	IR <sub>invertebrate</sub> (kg/kg BW day)	IR <sub>soil</sub> (kg/kg BW day)	P <sub>plant</sub>	P <sub>invertebrate</sub>	P <sub>mammal</sub>
Mourning Dove - Insectivore	0.230	0.120	0.0214	0	1	0
American Kestrel	0.0920	0.120	0.00460	0	0.200	0.800
Intake Estimates (mg/kg BW/day)						
	Plant Tissue	Invertebrate Tissue	Mammal Tissue	Soil	Surface Water	Total
<i>Mourning Dove - Insectivore</i>						
Tier 1 UTL	N/A	0.194	N/A	5.56E-04	0	0.194
Tier 1 UCL	N/A	0.175	N/A	5.03E-04	0	0.176
Tier 2 UTL	N/A	0.143	N/A	4.11E-04	0	0.143
Tier 2 UCL	N/A	0.111	N/A	3.19E-04	0	0.111
<i>American Kestrel</i>						
Tier 1 UTL	N/A	0.0155	0.0544	1.20E-04	0	0.0701
Tier 1 UCL	N/A	0.0140	0.0492	1.08E-04	0	0.0633
Tier 2 UTL	N/A	0.0114	0.0402	8.83E-05	0	0.0517
Tier 2 UCL	N/A	0.00888	0.0312	6.85E-05	0	0.0402

N/A = Not applicable or not available.

209

**Table A4.2.2**  
**Hazard Quotients for Surface Soils in the LWNEU - 4,4'-DDT**

Exposure Point Concentration	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
4,4'-DDT (Default Exposure Scenario)					
Mourning Dove - Insectivore					
Tier 1 UTL	0.194	0.009	1.50	21.6	0.130
Tier 1 UCL	0.176	0.009	1.50	19.5	0.117
Tier 2 UTL	0.143	0.009	1.50	15.9	0.0957
Tier 2 UCL	0.111	0.009	1.50	12.4	0.0742
American Kestrel					
Tier 1 UTL	0.0701	0.009	1.50	7.78	0.0467
Tier 1 UCL	0.0633	0.009	1.50	7.04	0.0422
Tier 2 UTL	0.0517	0.009	1.50	5.75	0.0345
Tier 2 UCL	0.0402	0.009	1.50	4.46	0.0268

**Bold = Hazard quotients > 1.**

**COMPREHENSIVE RISK ASSESSMENT**

**LOWER WALNUT DRAINAGE EXPOSURE UNIT**

**VOLUME 8: ATTACHMENT 5**

**Chemical-Specific Uncertainty Analysis**

## TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS.....	iii
1.0 INTRODUCTION.....	1
1.1 4,4'-DDT.....	1
2.0 REFERENCES.....	2

## **ACRONYMS AND ABBREVIATIONS**

BAF	bioaccumulation factor
CMS	Corrective Measures Study
CRA Methodology	Final Comprehensive Risk Assessment Work Plan and Methodology
ECOI	ecological contaminant of interest
ECOPC	ecological contaminant of potential concern
EcoSSL	ecological soil screening level
EPA	U.S. Environmental Protection Agency
HQ	hazard quotient
LOAEL	lowest observed adverse effect level
NOAEL	no observed adverse effect level
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
TRV	toxicity reference value

## 1.0 INTRODUCTION

One potential limitation of the hazard quotient (HQ) approach is that calculated HQ values may sometimes be uncertain due to simplifications and assumptions in the underlying exposure and toxicity data used to derive the HQs. Where possible, this risk assessment provides information on two potential sources of uncertainty, described below.

- **Bioaccumulation Factors (BAFs).** For wildlife receptors, concentrations of contaminants in dietary items were estimated from surface soil using uptake equations. When the uptake equation was based on a simple linear model (e.g.,  $C_{\text{tissue}} = \text{BAF} * C_{\text{soil}}$ ), the default exposure scenario used a high-end estimate of the BAF (the 90th percentile BAF). However, the use of high-end BAFs may tend to overestimate tissue concentrations in some dietary items. If necessary, in order to estimate more typical tissue concentrations, an alternate exposure scenario calculated total chemical intake using a 50th percentile (median) BAF. The use of the median BAF is consistent with the approach used in the ecological soil screening level (EcoSSL) guidance (U.S. Environmental Protection Agency [EPA] 2005).
- **Toxicity Reference Values (TRVs).** The Final Comprehensive Risk Assessment Work Plan and Methodology (CRA Methodology) (DOE 2004) used an established hierarchy to identify the most appropriate default TRVs for use in the ecological contaminant of potential concern (ECOPC) selection. However, in some instances, the default TRV selected may be overly conservative with regard to characterizing population-level risks. The determination of whether the default TRVs are thought to yield overly conservative estimates of risk is addressed in the uncertainty sections below on a chemical-by-chemical basis. If lowest observed adverse effect level (LOAEL) HQs greater than one were calculated using the default HQ calculations and when an alternate TRV is identified, the chemical-specific uncertainty sections provide a discussion of why the alternate TRV is thought to be appropriate to provide an alternative estimate of toxicity (e.g., endpoint relevance, species relevance, data quality, chemical form, etc.), and HQs were calculated using both default and alternate TRVs.

The influences of each of these uncertainties on the calculated HQs are discussed for each ECOPC in the following subsections.

### 1.1 4,4'-DDT

The uncertainties associated with the risk estimation for 4,4'-DDT are summarized below.

#### ***Bioaccumulation Factors***

Both invertebrate and small mammal tissue concentrations for 4,4'-DDT were estimated using uptake models based on the log  $K_{ow}$  of 4,4'-DDT. As cited in the CRA Methodology, if organic ecological contaminants of interest (ECOIs) with no empirically calculated BAFs available in the first two sources, log  $K_{ow}$  equations are used (as

presented and modified in the EPA EcoSSL [EPA 2003]). These values are more uncertain than empirically based BAFs and are likely to overestimate tissue concentrations to an unknown degree. This uncertainty is compounded in the soil-to-small mammal BAF that uses both the soil-to-invertebrate and soil-to-plant (also log  $K_{ow}$ -based) BAFs to estimate the diet of the small mammal. A second model is then used to estimate the amount of ECOI transferred from prey food to prey tissues. This compounded uncertainty may overestimate the concentrations of 4,4'-DDT by an even larger degree than was noted for the soil-to-invertebrate pathway.

#### ***Toxicity Reference Values***

Appendix B of the CRA Methodology presents a no observed adverse effect level (NOAEL) and LOAEL TRV for avian effects from 4,4'-DDT. However, the NOAEL was estimated from the LOAEL. As such, it does not reflect a laboratory measured value. Given the uncertainty in the NOAEL TRV, the risks calculated using the NOAEL may be either overestimated or underestimated to an unknown degree. The LOAEL was based on observed increases in adverse reproductive effects in mallards. The confidence placed in this value was high. No alternative TRVs are recommended.

#### ***Background Risk Calculations***

4,4'-DDT was not analyzed for in background surface soils. Therefore, background risks were not calculated for 4,4'-DDT in Appendix A, Volume 2, Attachment 9 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report).

## **2.0 REFERENCES**

- DOE, 2004. Final Comprehensive Risk Assessment Work Plan and Methodology, Rocky Flats Environmental Technology Site, Golden, Colorado. September.
- EPA, 2003. Guidance for Developing Ecological Soil Screening Levels (EcoSSLs). OSWER 9285.7-55. Office of Solid Waste and Emergency Response. December.
- EPA, 2005. Guidance for Developing Ecological Soil Screening Levels (EcoSSLs). Attachment 4-1 Update. Office of Solid Waste and Emergency Response. February.

**COMPREHENSIVE RISK ASSESSMENT**

**LOWER WALNUT DRAINAGE EXPOSURE UNIT**

**VOLUME 8: ATTACHMENT 6**

**CRA Analytical Data Set**